MECHANISMS in Modern Engineering Design

A Handbook
for Engineers,
Designers and Inventors

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Volume

II

Lever Mechanisms

Part 2

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SECTION SIX

Lever-Cam Mechanisms

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2. General-Purpose Five-Link Mechanisms 5L (1688 through 1697)
3. General-Purpose Multiple-Link Mechanisms ML (1698)
4. Clutch and Coupling Mechanisms C (1699 and 1700)
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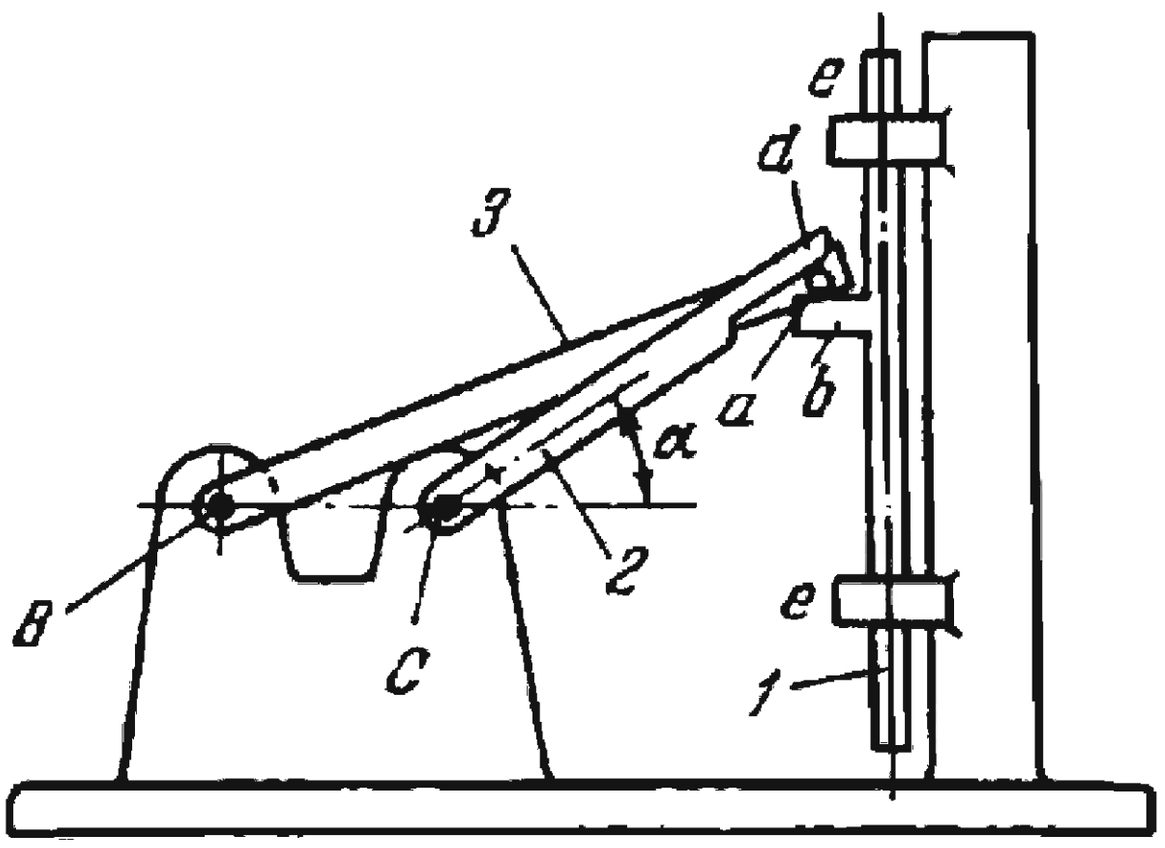
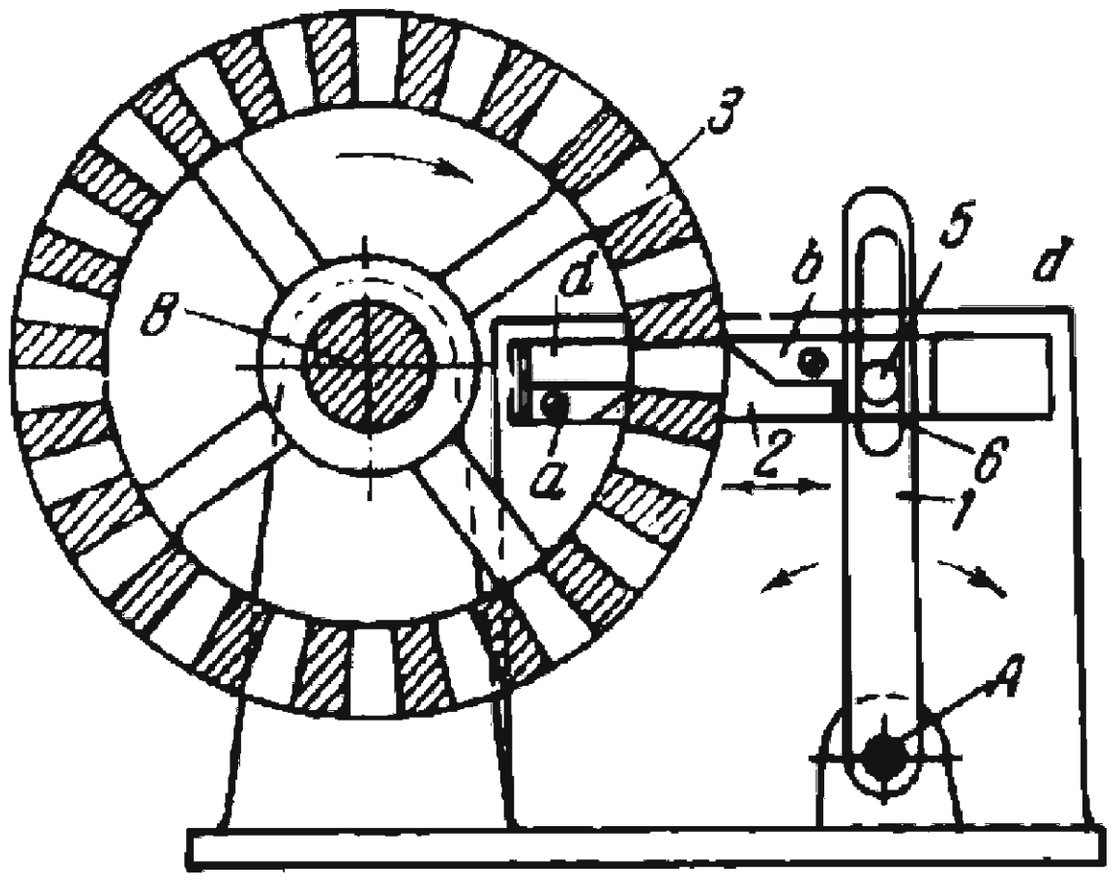
1. GENERAL-PURPOSE FOUR-LINK MECHANISMS (1684 through 1687)

1684	LEVER-CAM MECHANISM WITH APPROXIMATELY UNIFORM MOTION OF THE DRIVEN LINK	LC 4L



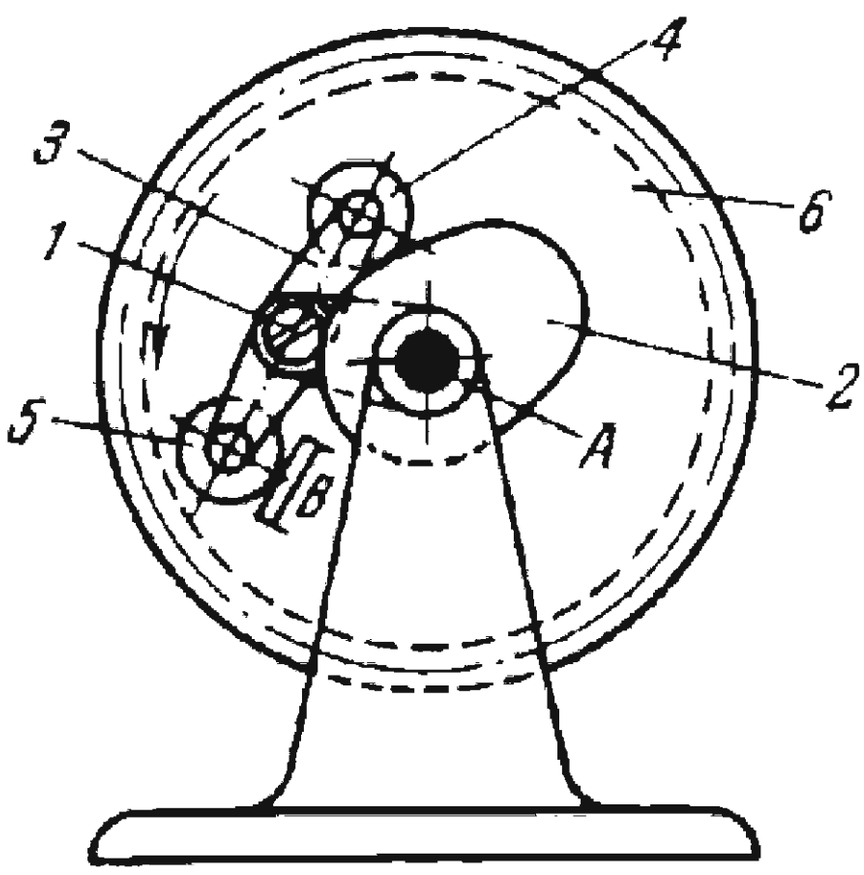
The lengths of the links comply with the condition: $\overline{BC} = 0.34\ \overline{Ba}$. Link *3*, turning about fixed axis *B*, carries pin *a* which slides along projection *b* of link *1*. Link *1* slides in fixed guides *e*-*e*. Link *2*, turning about fixed axis *C*, has lug *d* which slides along pin *a*. The upper surface of projection *b* makes an angle of 90° with the axis of guides *e*-*e*. When link *2* turns with uniform velocity through angle α on both sides of line *BC*, link *1* moves with approximately uniform velocity.

1685	LEVER-CAM MECHANISM WITH RECIPROCATING CAMS	LC 4L



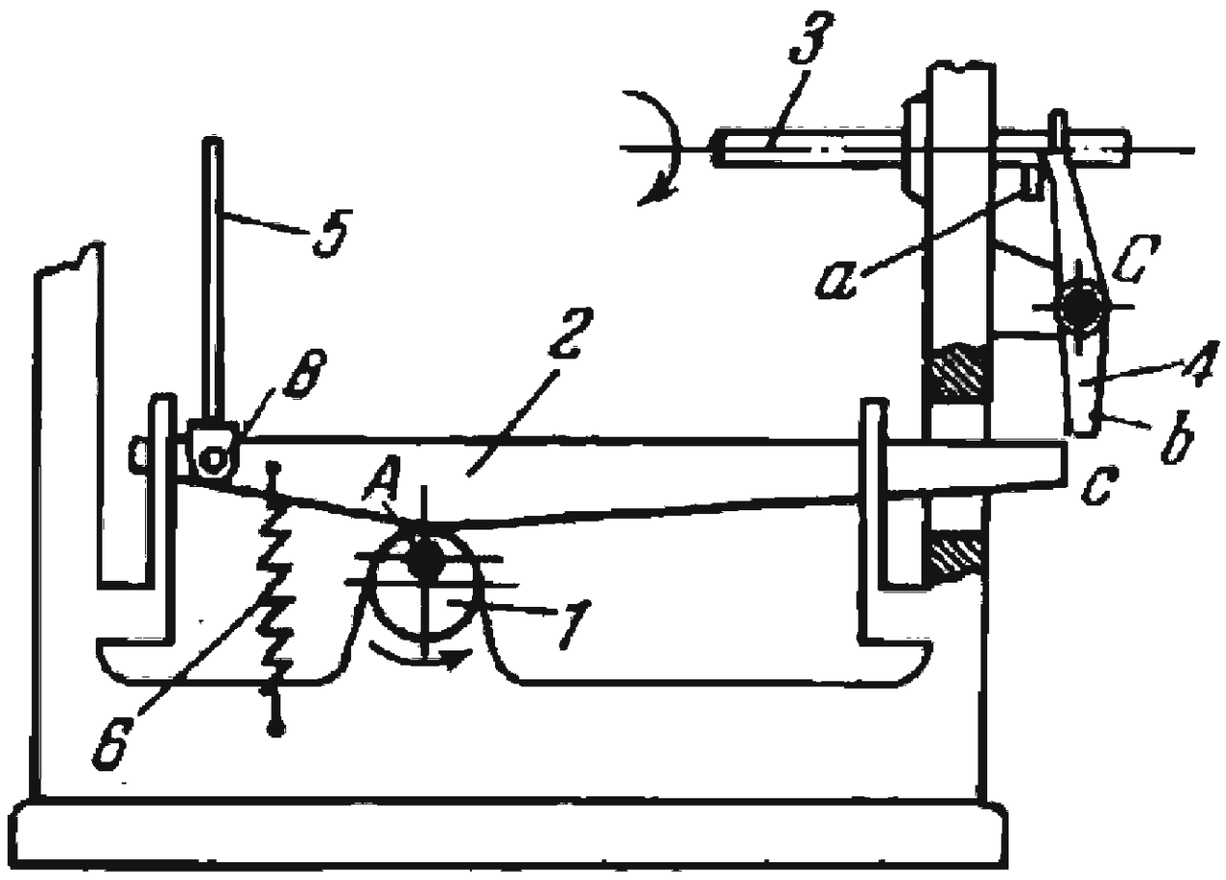
Wheel *3* rotates about fixed axis *B*. Lever *1*, oscillating about fixed axis *A*, has axial slot *6* which, by means of pin *5*, reciprocates slide *2* along fixed guides *d*-*d*. Cams *a* and *b*, mounted on slider *2*, alternately enter the radial slots of wheel *3*, effecting its continuous rotation.

1686	LEVER-CAM MECHANISM WITH A FIXED CAM	LC 4L



Driving link *1* rotates about fixed axis *A*. Pivoted to link *1* is two-arm lever *3* having rollers *4* and *5* at its ends. Roller *4* runs around fixed cam *2*. Roller *5*, bearing against lug *B* of gear *6*, rotates this gear with variable angular velocity. Gear *6* makes one revolution to each revolution of link *1*.

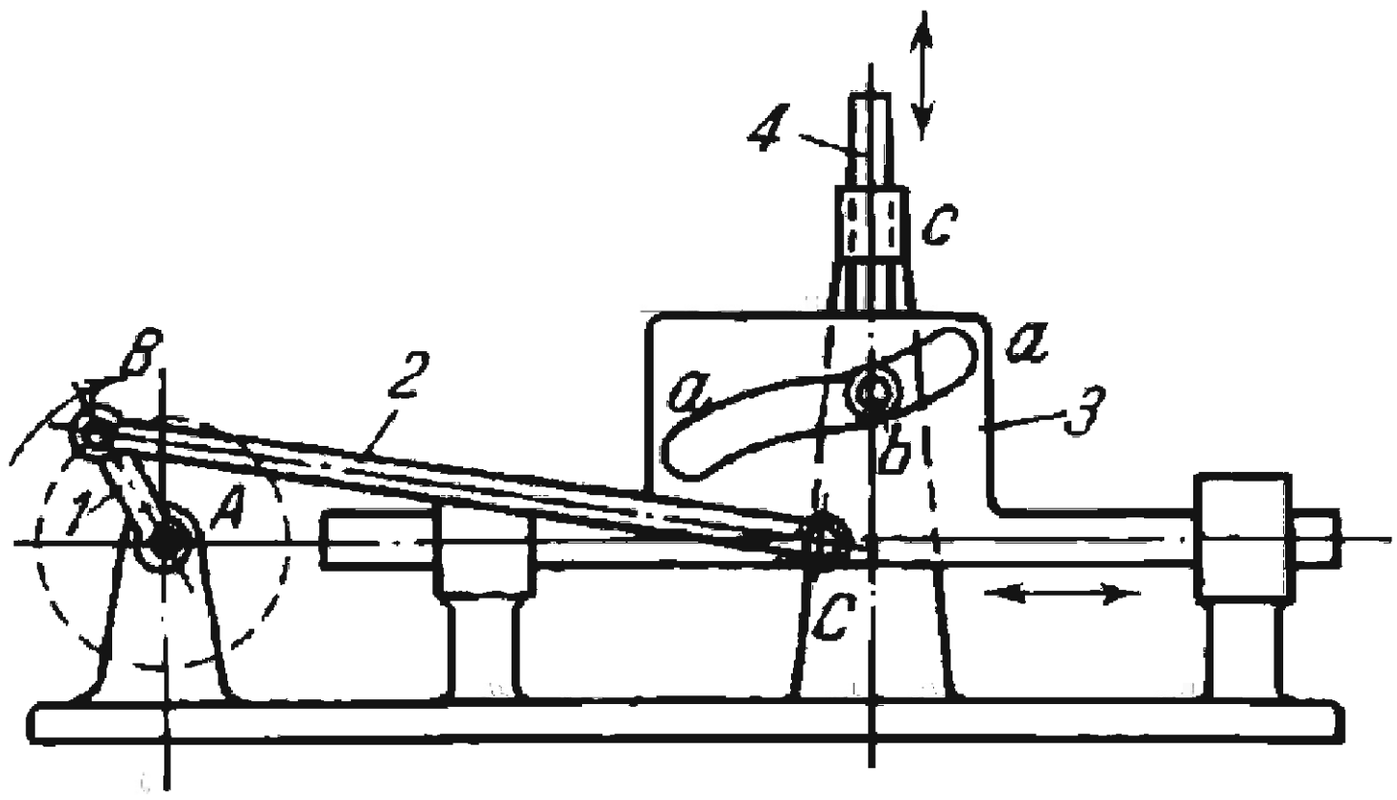
1687	LEVER-CAM MECHANISM WITH AN ECCENTRIC	LC 4L



When eccentric *1* rotates about fixed axis *A*, the right end of lever *2*, whose left end is connected to tie-rod *5* by turning pair *B*, oscillates about axis *B* as if it were a fixed axis. If pin *a*, rotating together with shaft *3*, turns lever *4* clockwise about fixed axis *C*, then end *b* of the lever will engage right end *c* of lever *2* and prevent its oscillation. After this, rotation of eccentric *1* will oscillate the left end of lever *2* together with tie-rod *5*. Spring *6* holds lever *2* in contact with eccentric *1*.

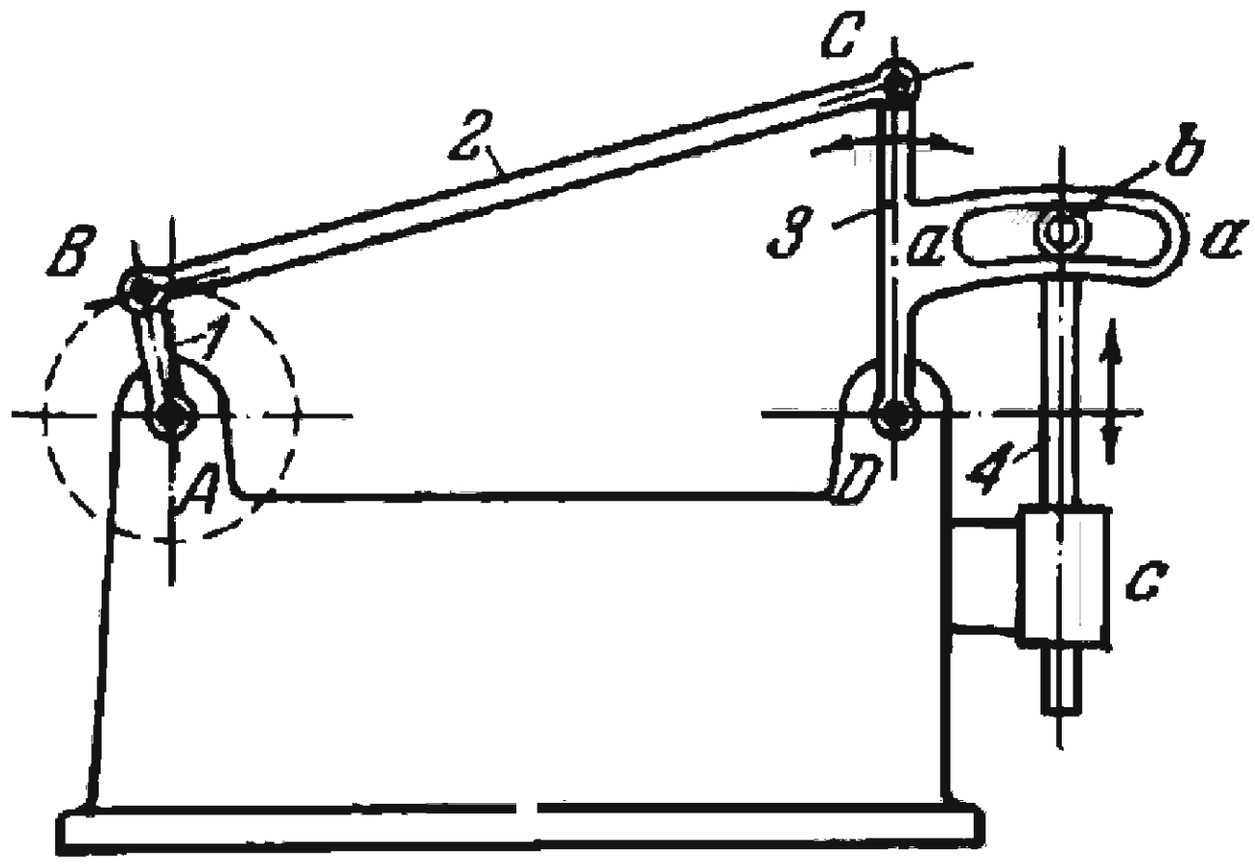
2. GENERAL-PURPOSE FIVE-LINK MECHANISMS
(1688 through 1697)

1688	SLIDER-CRANK LEVER-CAM MECHANISM	LC 5L



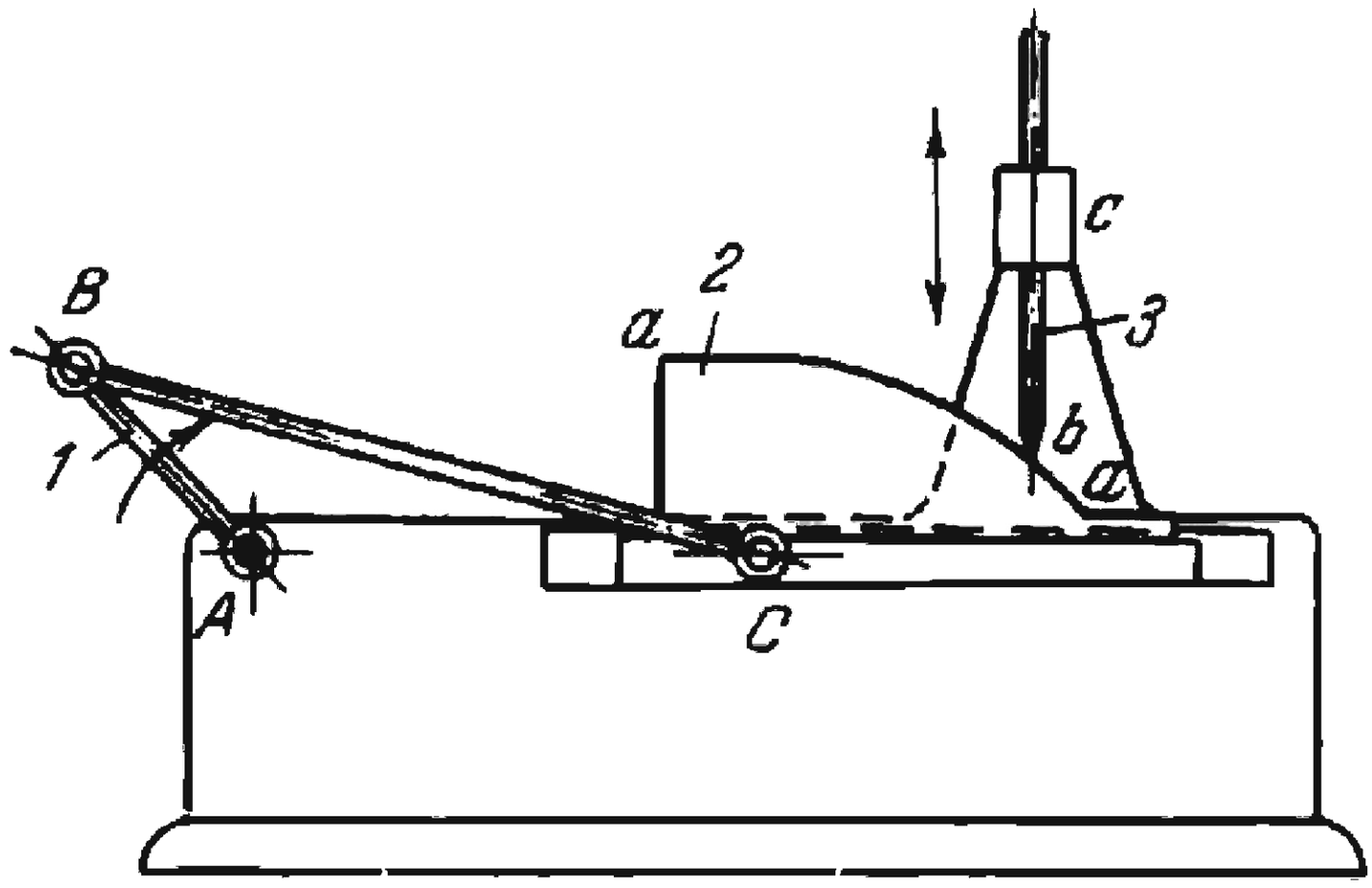
Slider *3* of the slider-crank linkage *ABC* has slot *a-a* of special profile along which roller *b* of link *4* slides and rolls. Link *4* reciprocates in fixed guide *c*. Reciprocation of slider *3* is converted into reciprocating motion of pusher *4*.

1689	LINKWORK CAM MECHANISM	LC 5L



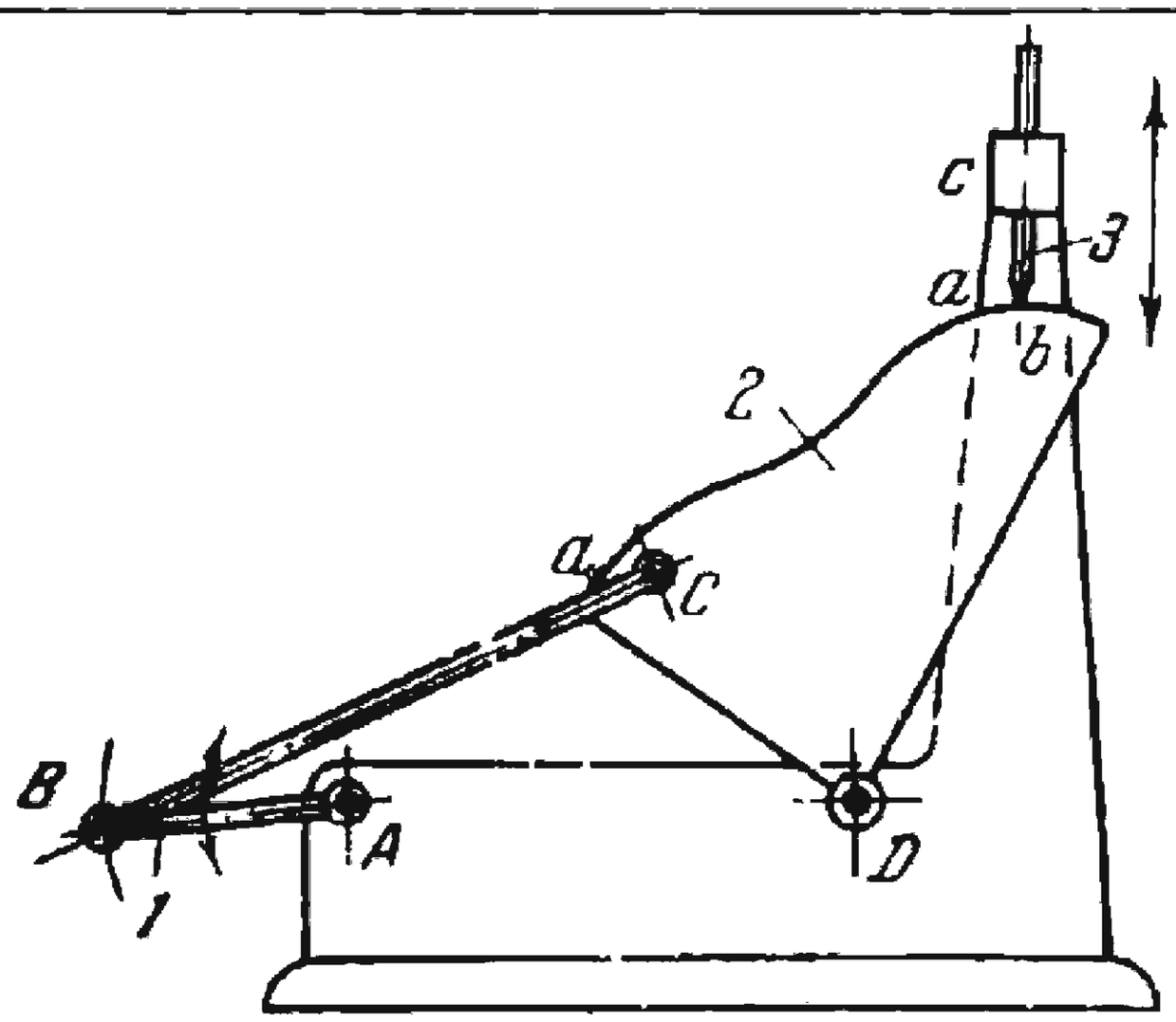
Rocker arm *3* of four-bar linkage *ABCD* has slot *a-a* of special profile along which roller *b* of link *4* slides and rolls. Link *4* reciprocates in fixed guide *c*. Oscillation of rocker arm *3* is converted into reciprocating motion of pusher *4*.

1690	SLIDER-CRANK LEVER-CAM MECHANISM	LC 5L

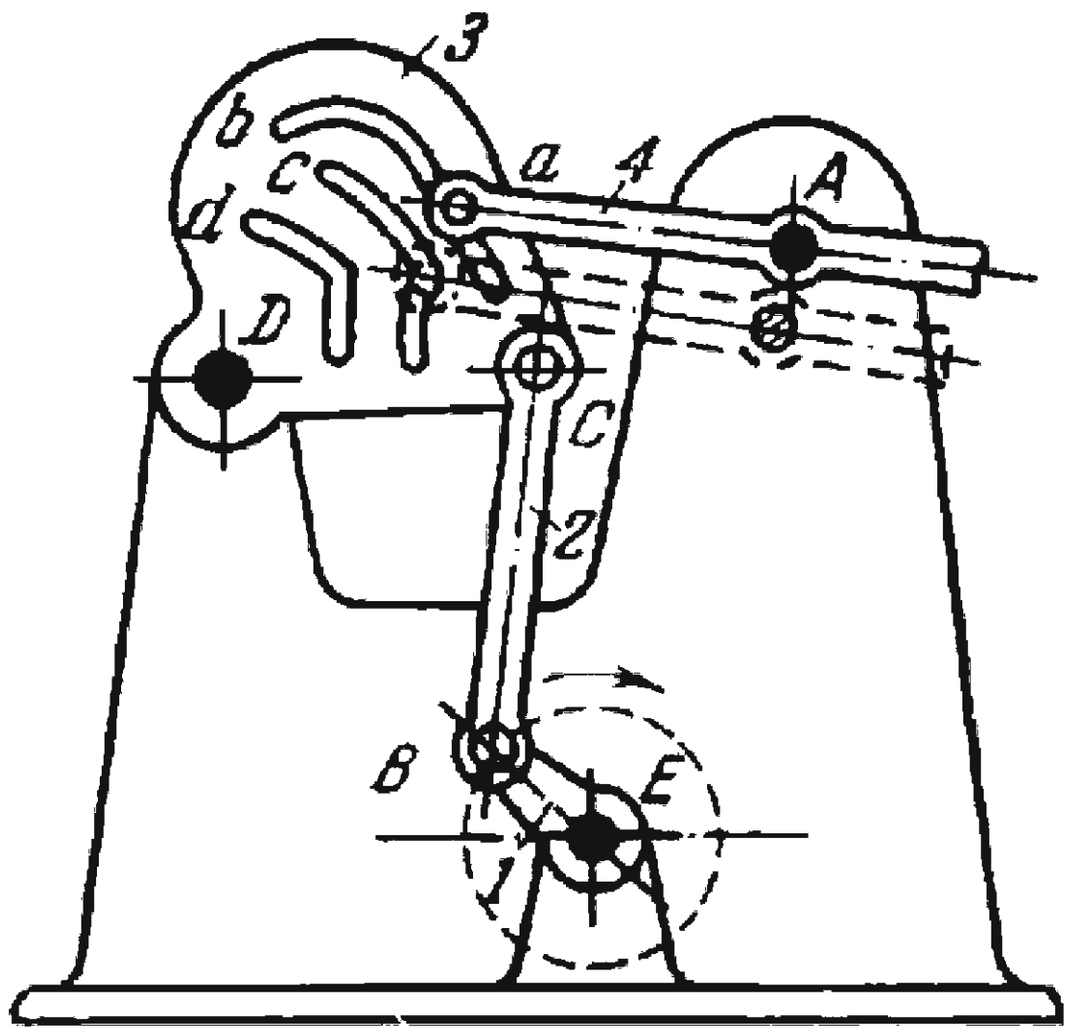


Slider *2* of slider-crank linkage *ABC* has cam surface *a-a* of special shape along which point *b* of pusher *3* slides. Pusher *3* reciprocates in fixed guide *c*. When crank *1* rotates about fixed axis *A*, slider *2* reciprocates in the horizontal direction, thereby moving pusher *3* in the vertical direction. Pusher *3* is held in contact with profiled surface *a-a* by means of a spring which is not shown.

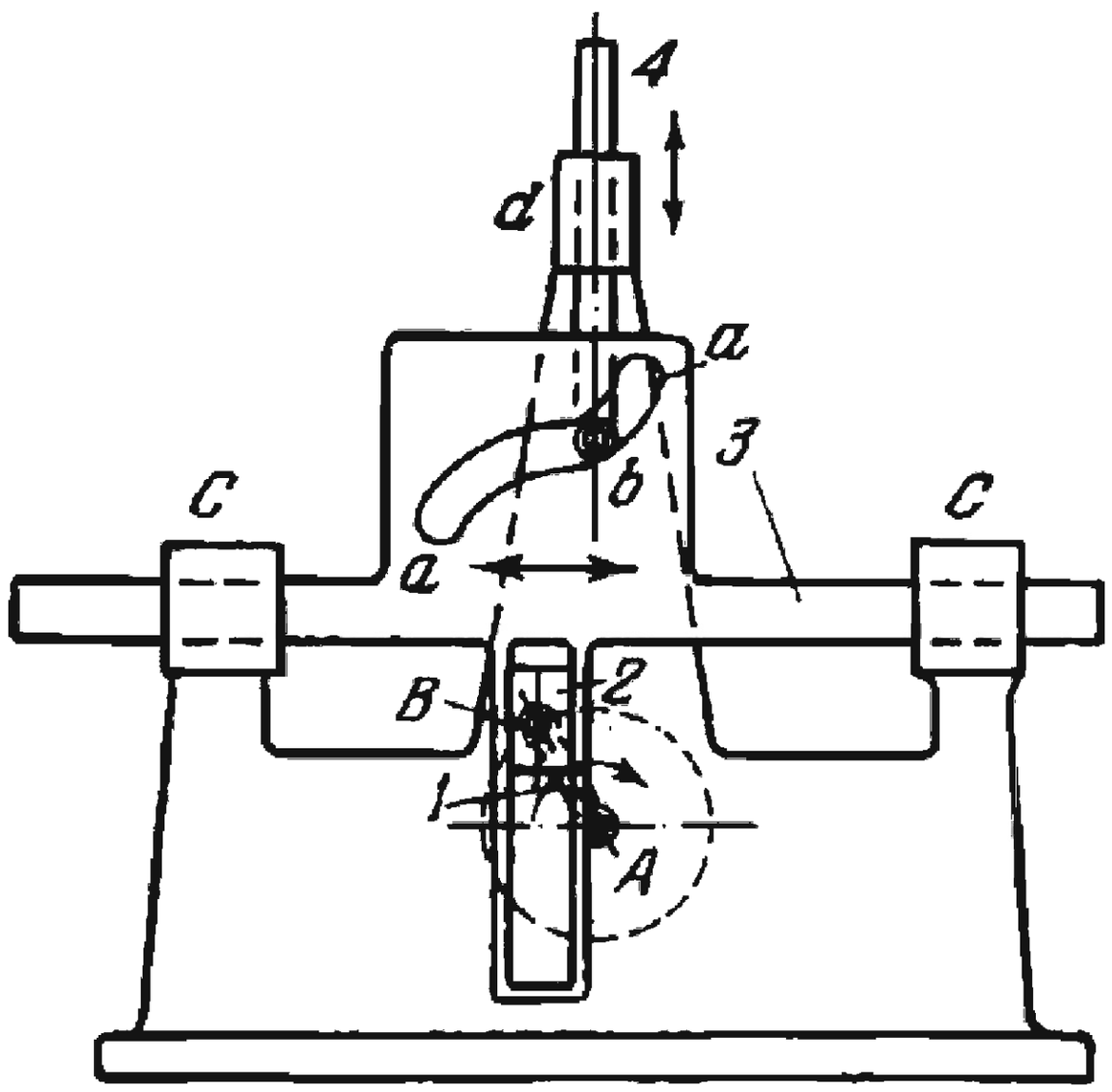
1691	LINKWORK CAM MECHANISM	LC 5L



Rocker arm *2* of four-bar linkage *ABCD* has cam surface *a-a* of special shape along which point *b* of pusher *3* slides. Pusher *3* reciprocates in fixed guide *c*. When crank *1* rotates about fixed axis *A*, cam *2* reciprocates pusher *3* in the vertical direction. Pusher *3* is held in contact with profiled surface *a-a* by means of a spring which is not shown.

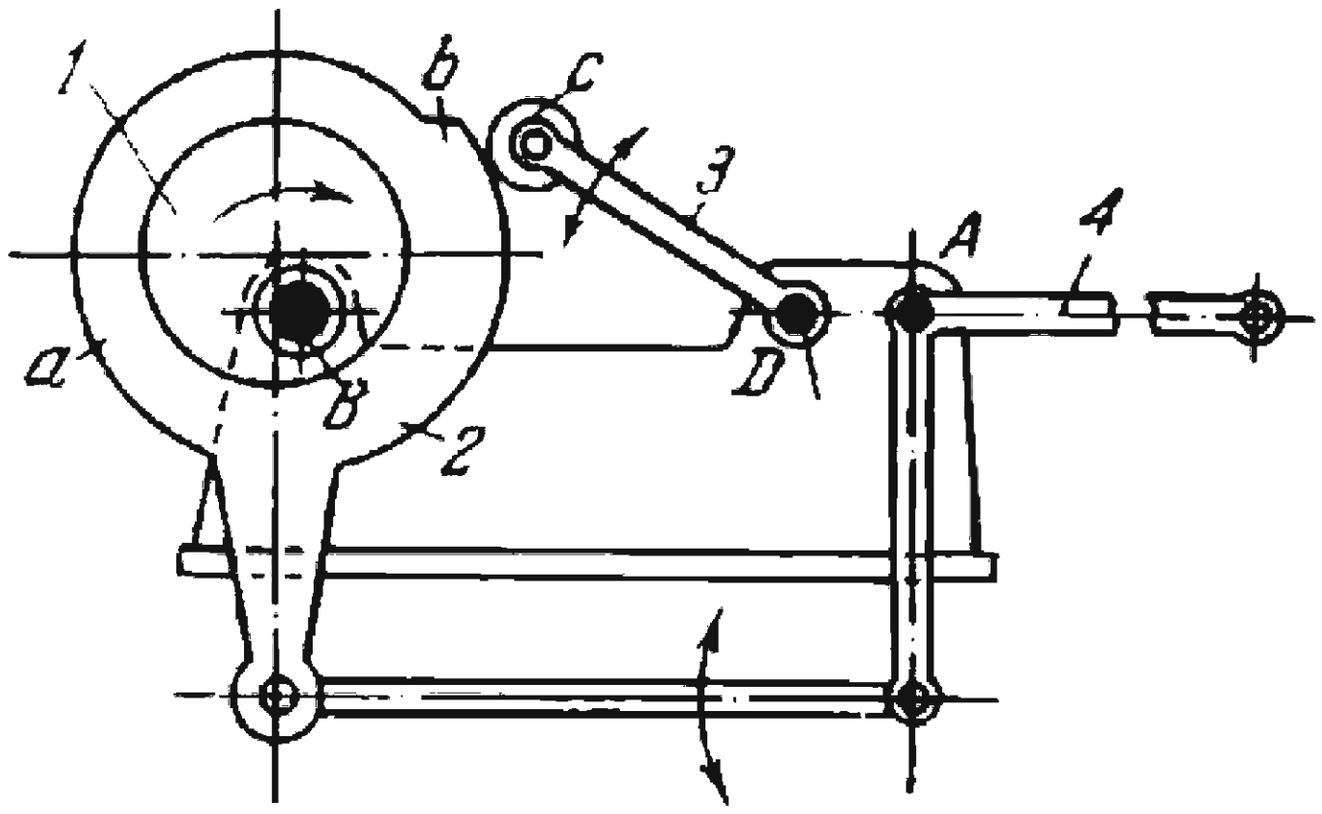


Rocker arm *3* of four-bar linkage *EBCD* has three slots, *b*, *c* and *d*, of special profiles in which roller *a* of link *4* can slide. Link *4* oscillates about fixed axis *A*. The law of motion of link *4* can be varied by changing the position of the centre of rotation *A* and by inserting roller *a* into another slot (of different profile) in rocker arm *3*. Dash lines show another possible position of link *4*.



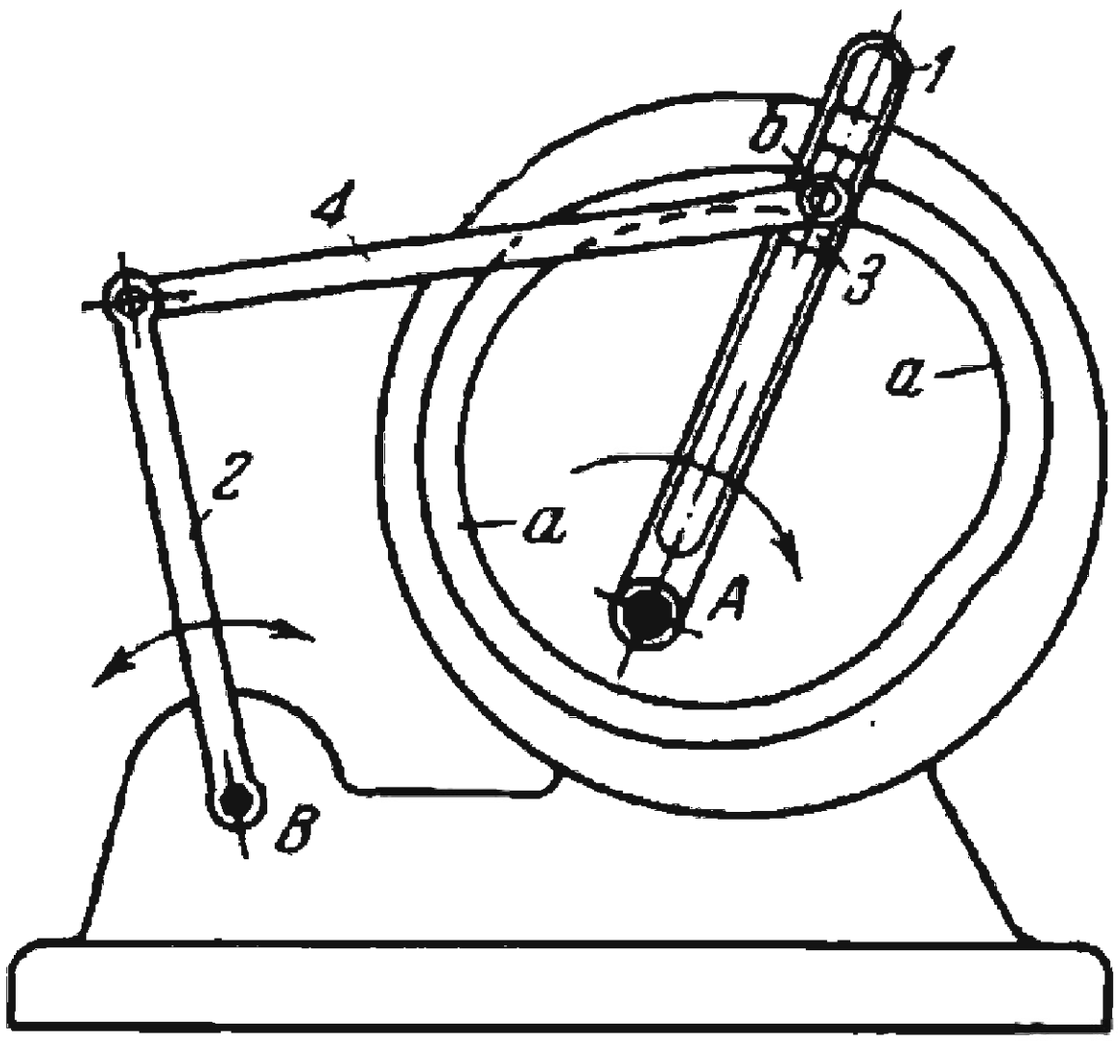
Slider *3* of link-gear mechanism *ABC* has slot *a-a* of special profile along which roller *b* of link *4* slides and rolls. Link *4* reciprocates in fixed guide *d*. Reciprocation of slider *3* is converted into reciprocating motion of pusher *4*.

1694	LINKWORK CAM MECHANISM WITH ADJUSTABLE DRIVEN LINK MOTION	LC 5L



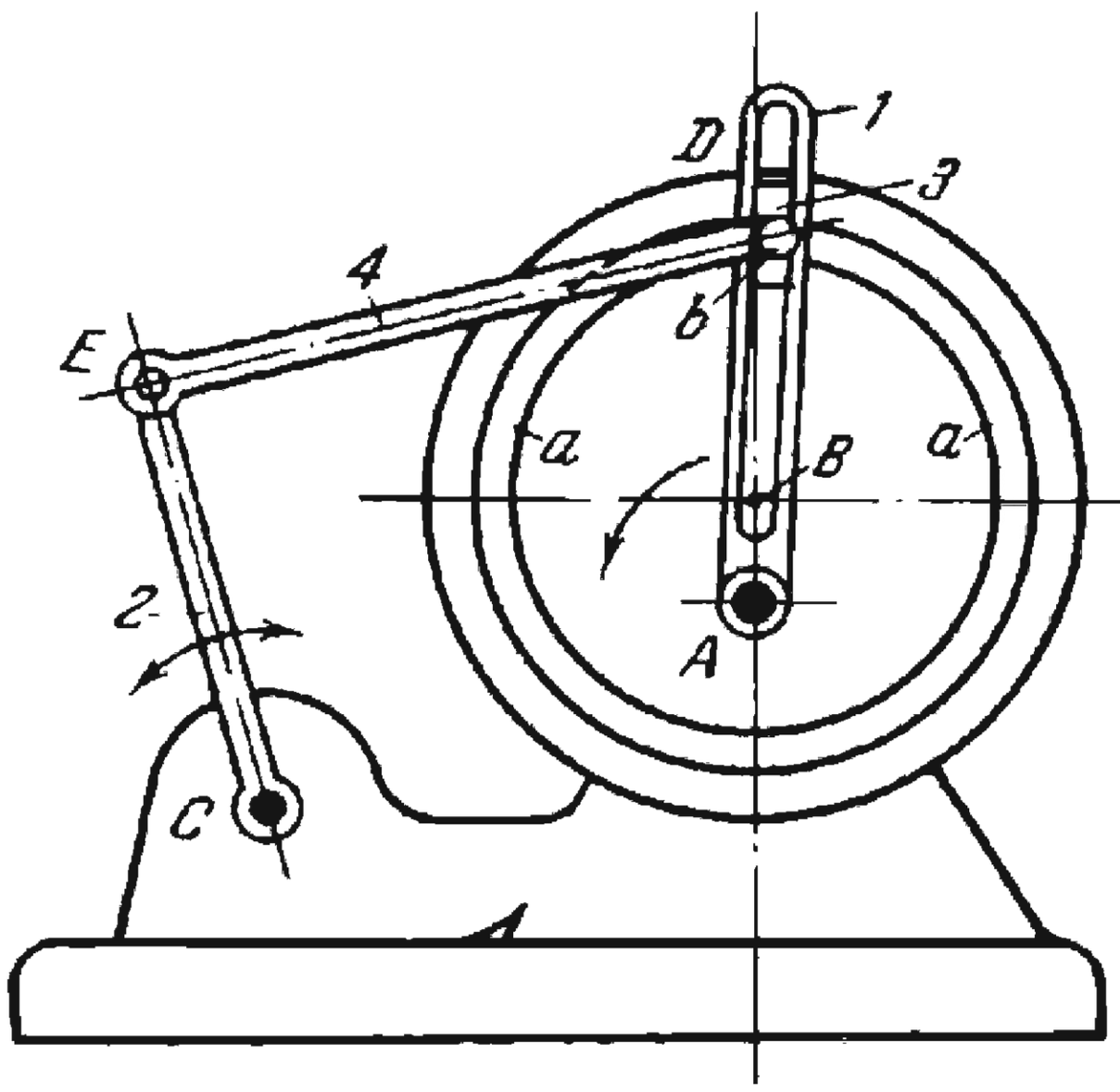
Link *1* is designed as a round eccentric rotating about fixed axis *B*. Link *2* has collar *a* encircling eccentric *1*. Collar *a* has cam surface *b* of special shape along which roller *c* of link *3* rolls. Link *3* oscillates about fixed axis *D*. Bent lever *4* is fixed during operation and rotation of eccentric *1* is transmitted through link *2* to link *3* with roller *c*. Motion of link *3* is regulated by turning lever *4* about fixed axis *A* and clamping it. This changes the law of motion of link *3*.

1695	LINK-GEAR FIXED-SLOT CAM MECHANISM	LC 5L



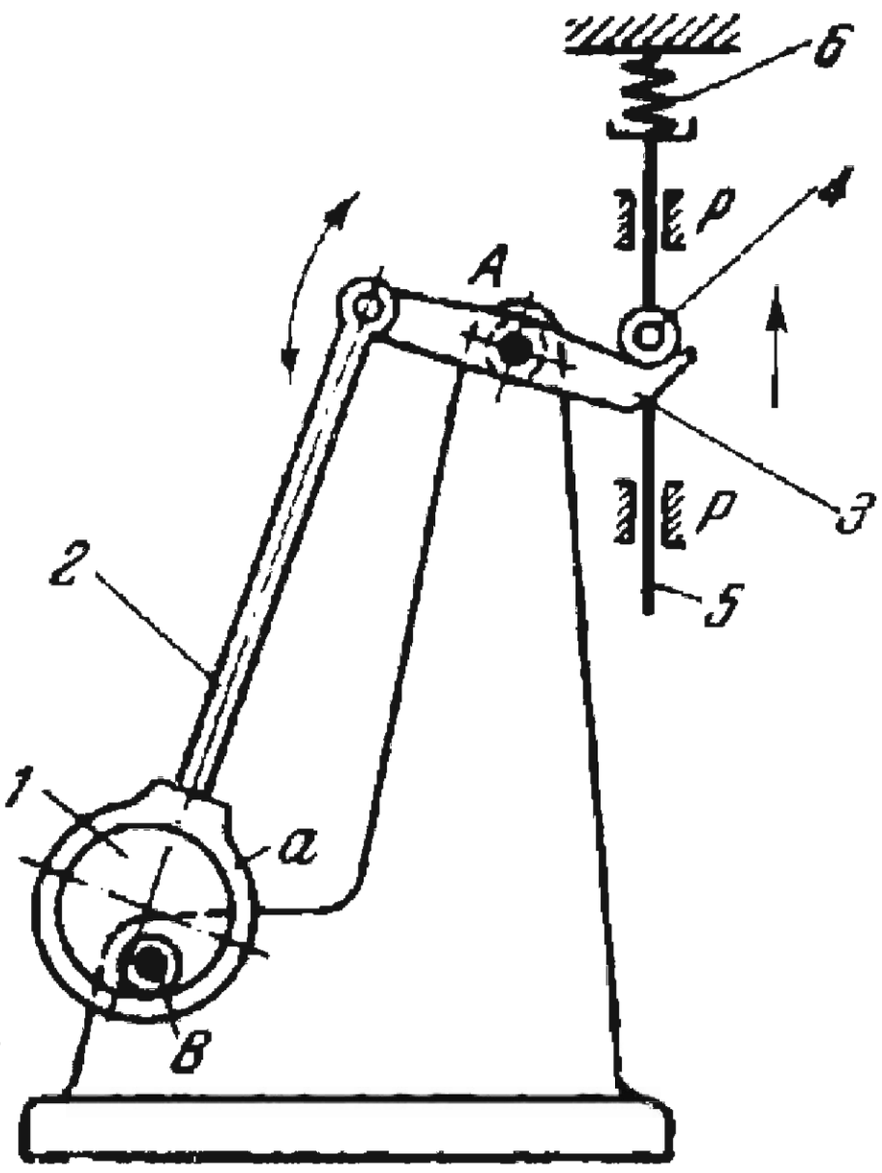
Slotted link *1* rotates about fixed axis *A*. Slider *3*, moving along the slot of link *1*, has roller *b* which slides and rolls along fixed slot *a-a* of special profile. Intermediate link *4* transmits oscillating motion to link *2* about fixed axis *B*.

1696	LINK-GEAR CAM MECHANISM WITH A FIXED CIRCULAR SLOT	LC 5L



Slotted link *1* rotates about fixed axis *A*. Slider *3*, moving along the slot of link *1*, has pin *b* which slides along fixed circular slot *a-a* with its centre at point *B*. Intermediate link *4* transmits oscillating motion to link *2* about fixed axis *C*.

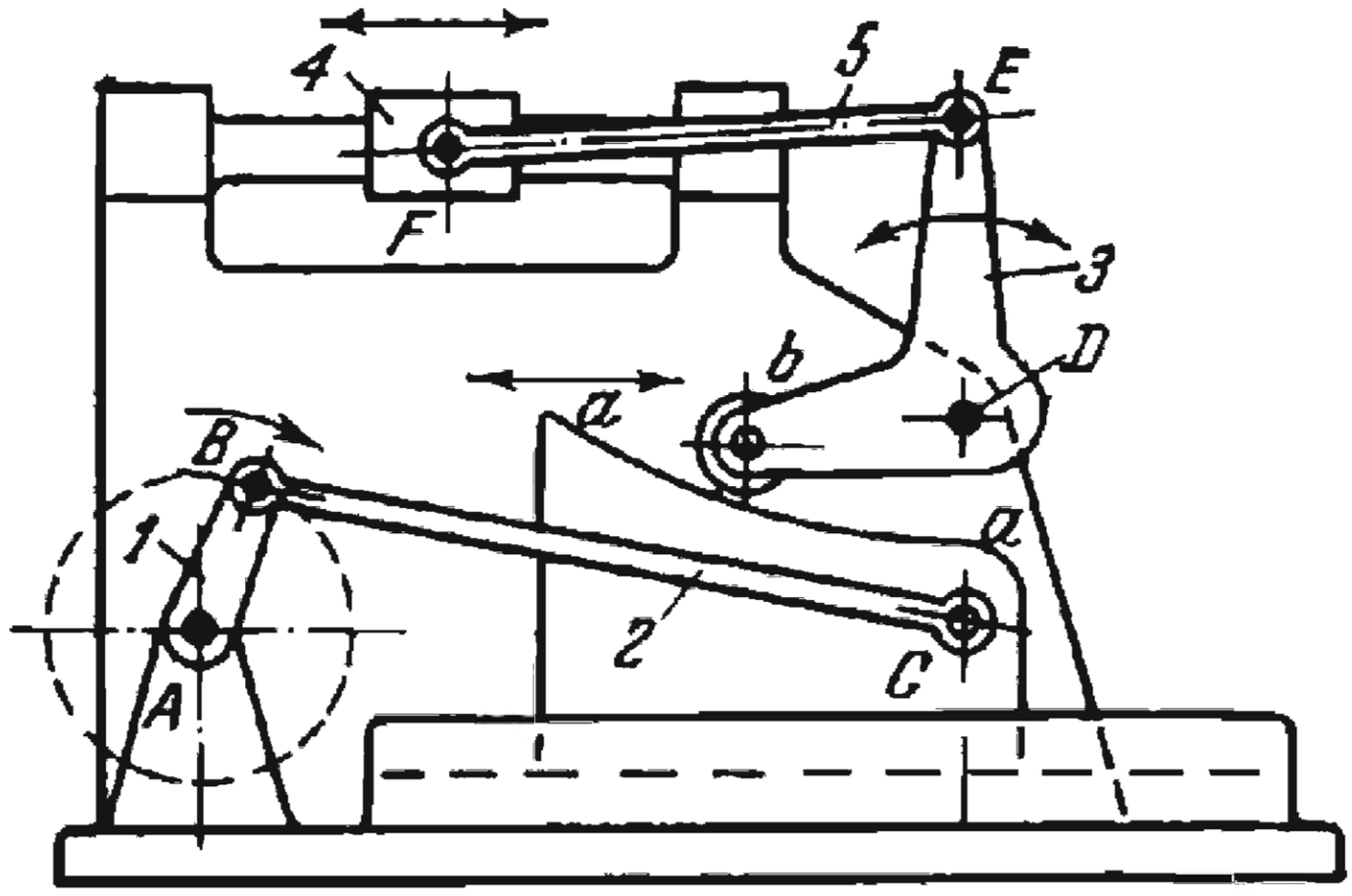
1697	LEVER-CAM MECHANISM WITH AN ECCENTRIC	LC 5L



Eccentric *1* rotates about fixed axis *B*. Link *2* has collar *a* encircling round eccentric *1*. Cam *3* turns about fixed axis *A*. Link *5* has roller *4* and slides in fixed guides *p-p*. Spring *6* holds roller *4* in contact with cam *3*. When eccentric *1* rotates about axis *B*, cam *3* oscillates about axis *A*, transmitting reciprocating motion to link *5*.

3. GENERAL-PURPOSE MULTIPLE-LINK MECHANISMS (1698)

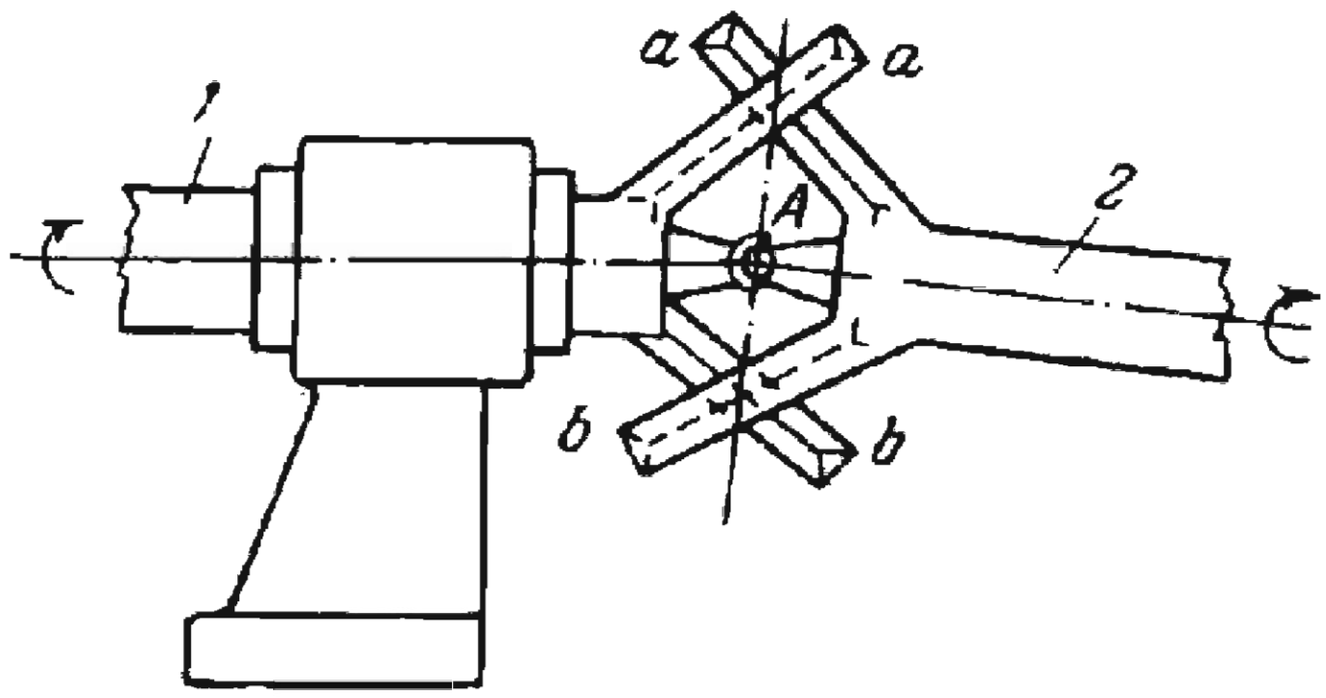
1698	SLIDER-CRANK LEVER-CAM MECHANISM	LC ML



Slider *2* of slider-crank linkage ABC has cam surface *a*-*a* of special shape along which roller *b* of link *3* rolls. Link *3* oscillates about fixed axis D. Slider *4* of slider-crank linkage DEF is reciprocated by the motion of link *3*.

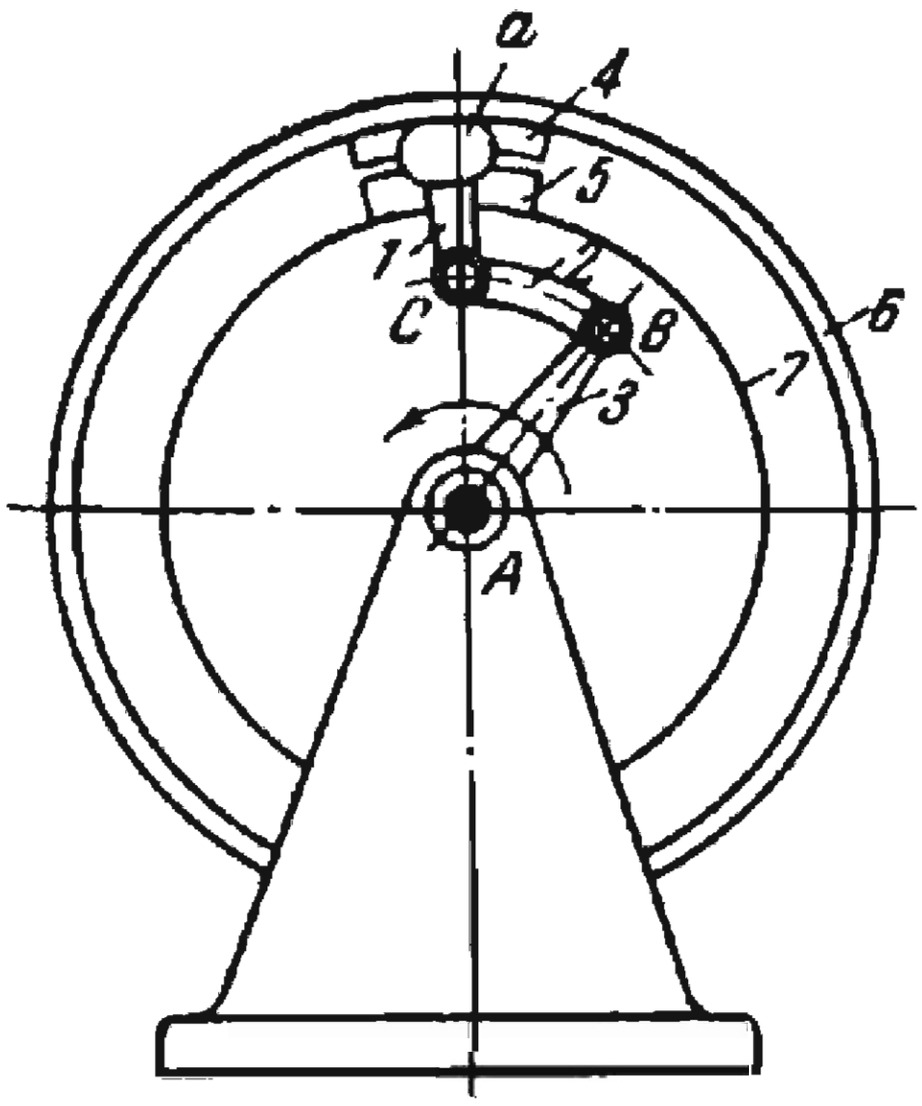
4. CLUTCH AND COUPLING MECHANISMS (1699 and 1700)

1699	LEVER-CAM SPATIAL COUPLING	LC C



Link *1* is connected by spherical pair *A* to link *2*. Links *1* and *2* have prongs *a* and *b* of triangular cross section, contacting one another along straight edges. Rotation is transmitted from shaft *1* to shaft *2* under the condition that their axes intersect at the single common point *A*.

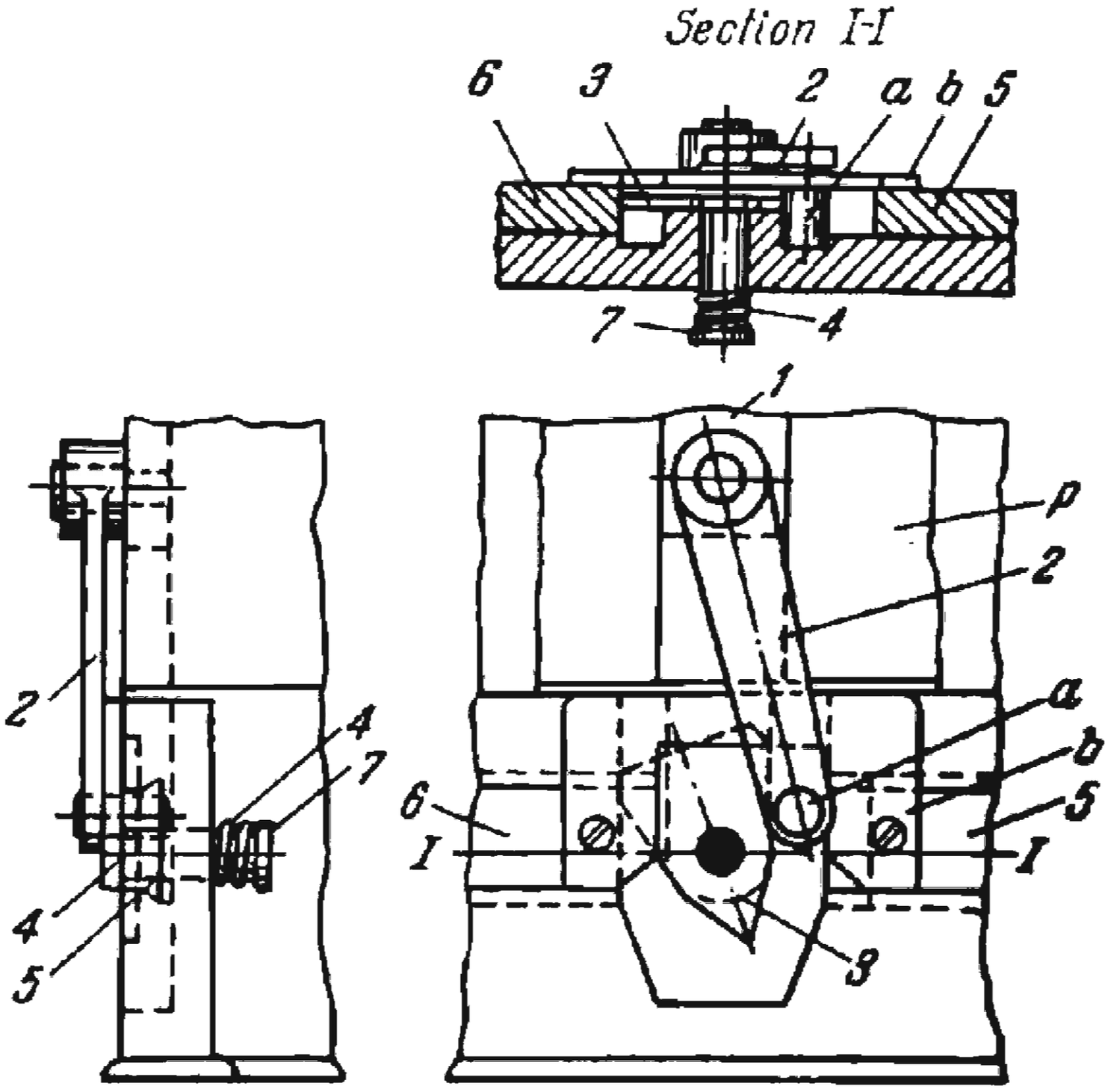
1700	LEVER-CAM FRICTION CLUTCH MECHANISM	LC C



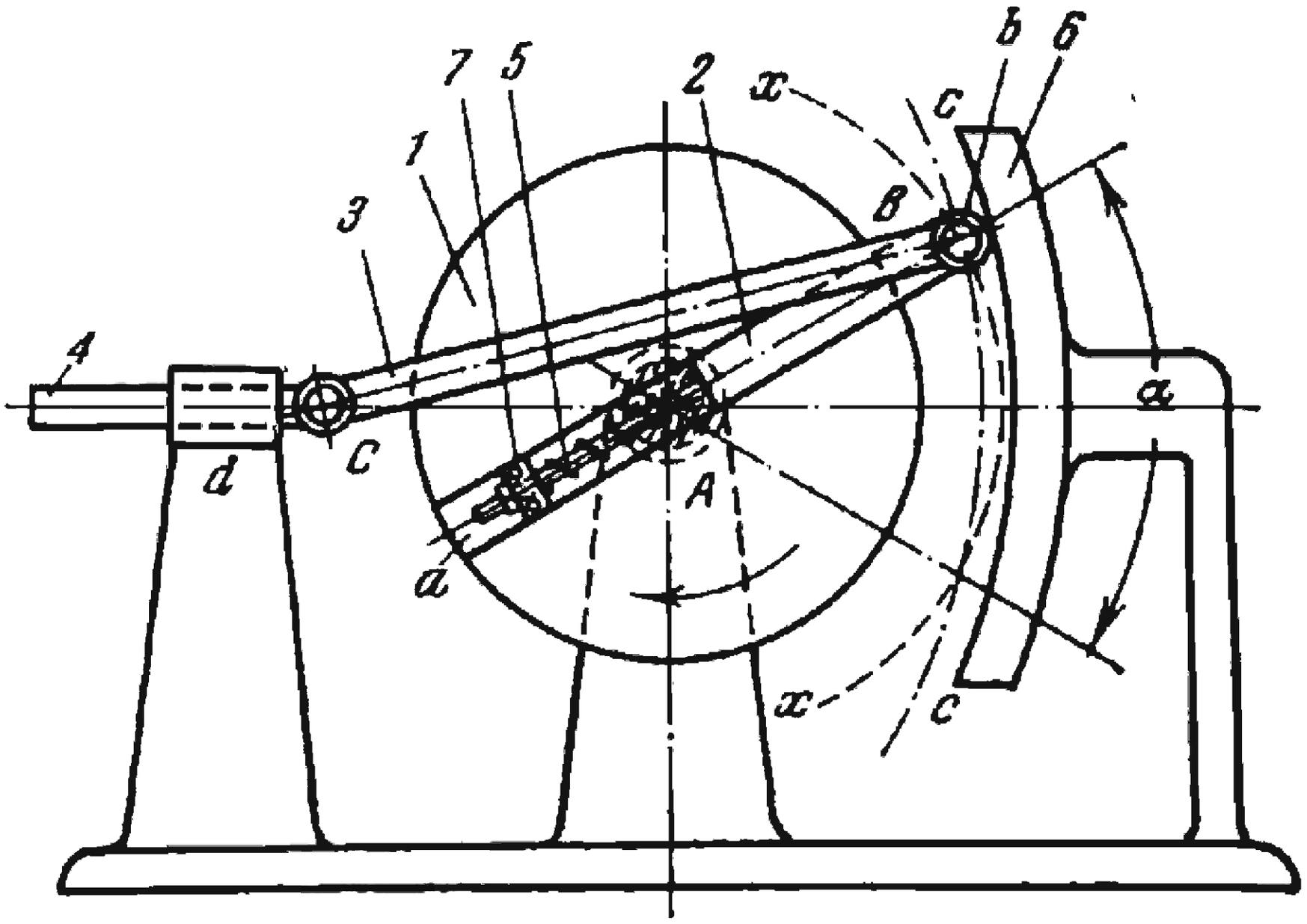
Link *3* rotates together with disk *7* about fixed axis *A*. Link *2* is connected by turning pairs *B* and *C* to links *3* and *1*. Link *1* has cam *a* of oval shape at its other end. When link *3* is turned counterclockwise with respect to disk *7*, shoes *4* and *5* are spread by cam *a* in the slot between disks *7* and *6*, thereby engaging the clutch so that disk *6* begins to rotate. When link *3* is turned in the opposite direction with respect to disk *7*, the clutch is disengaged and disk *6* stops rotating. The mechanism is held in the disengaged position when pivot *C* bears against a pin which is not shown.

5. DWELL MECHANISMS (1701, 1702 and 1703)

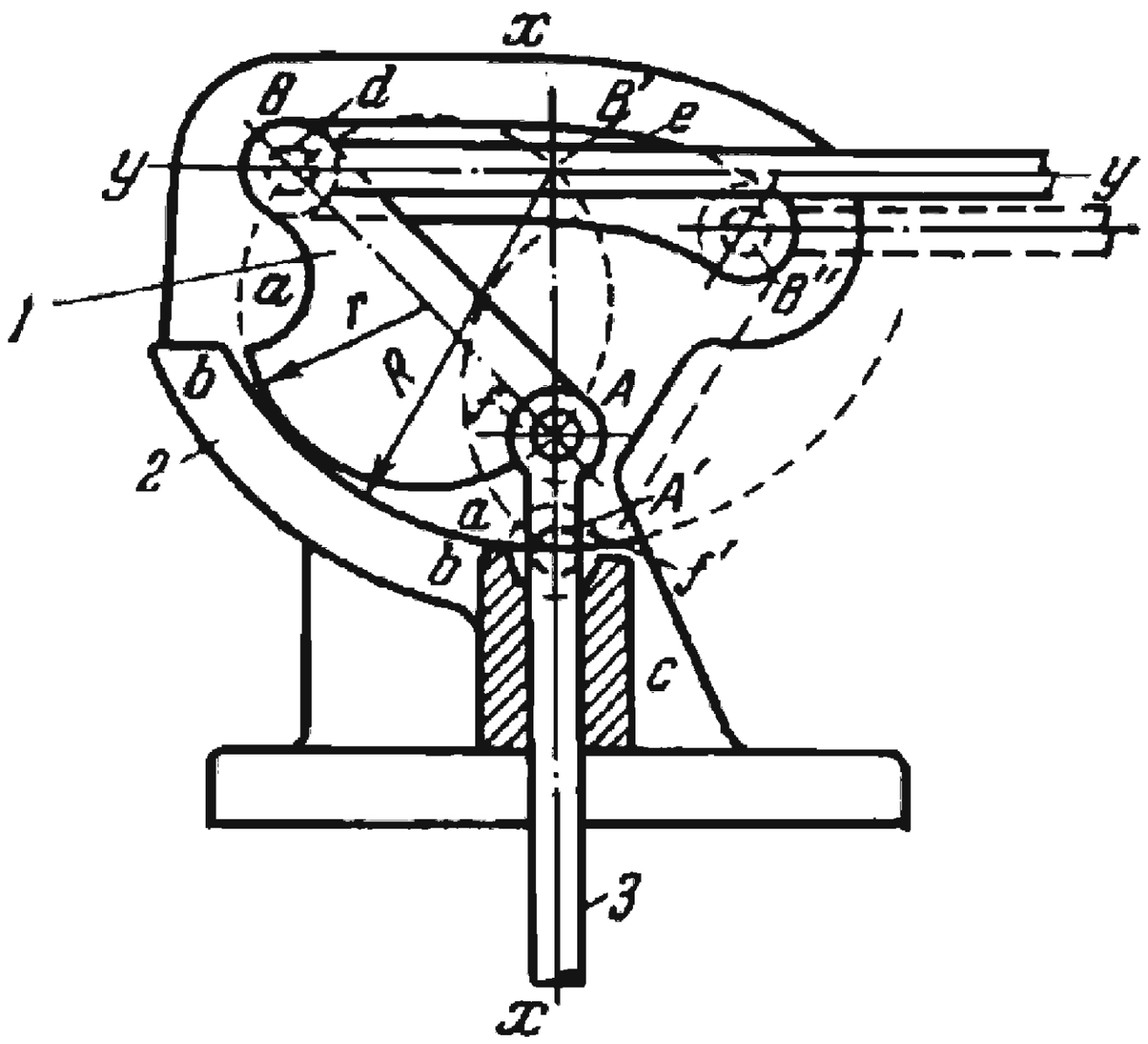
1701	LEVER-CAM MECHANISM FOR CONVERTING RECIPROCATING INTO INTERMITTENT MOTION	I C D



When slider *1* reciprocates along fixed guide *p*, roller *a* of lever *2* rolls around cam *3* thereby transmitting reciprocating motion to sliders *5* and *6* which are joined together by plate *b*. Spring *4* provides a friction drag between the upright and flange *7* to prevent unintentional rotation of cam *3*.



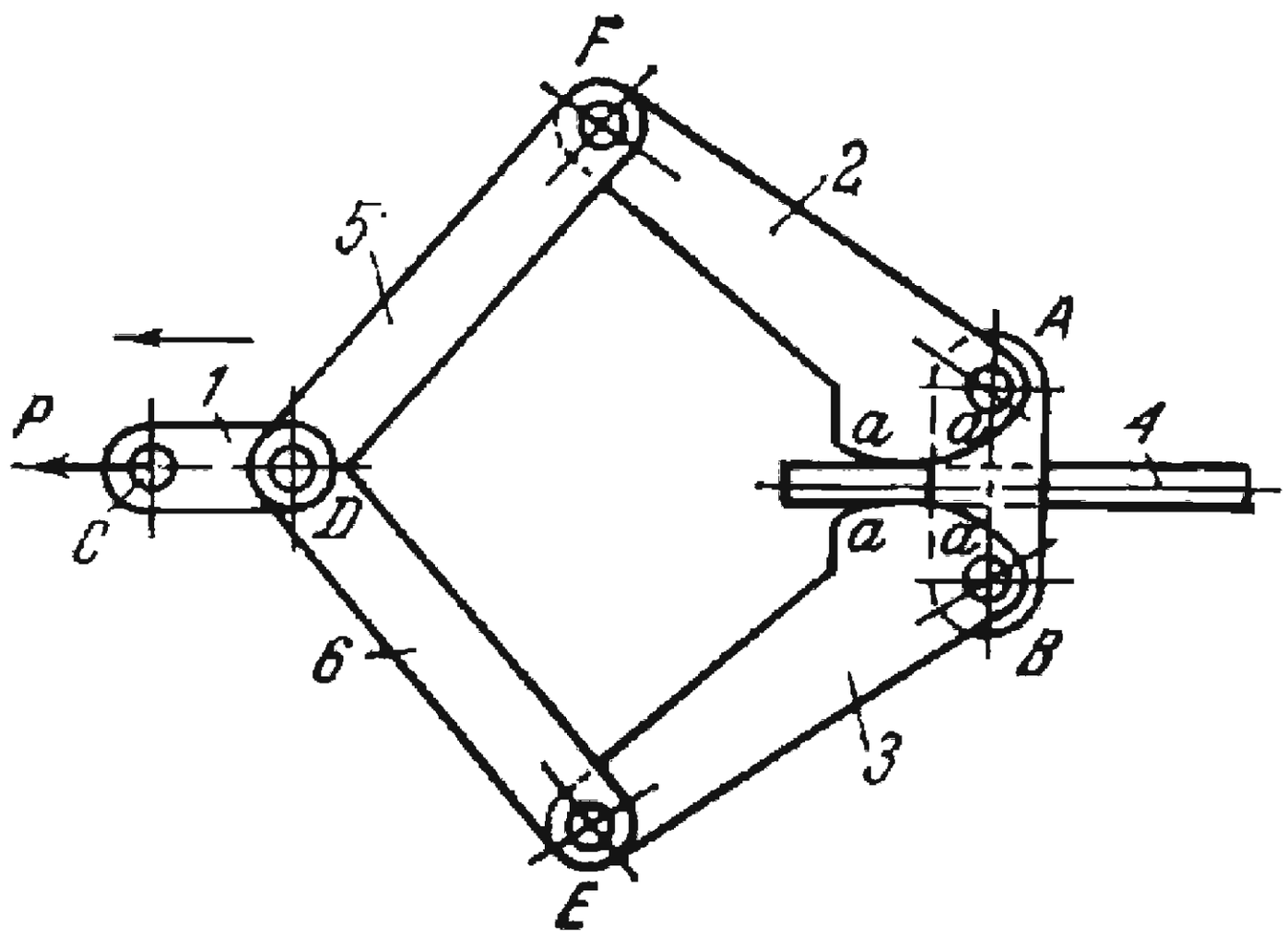
Disk *1*, having slot *a*, rotates about fixed axis *A*. Link *4* reciprocates in fixed guide *d*. When disk *1* rotates, motion is transmitted through connecting rod *3* to link *4*. Connecting rod *3* is connected by turning pairs *B* and *C* to links *2* and *4*. Link *2* slides in slot *a* of disk *1* and is activated by spring *5* whose other end bears against strip *7* which is secured to disk *1*. Roller *b* is mounted on pin *B*. While roller *b* is not in contact with surface *c-c* of special profile on fixed cam *6*, point *B* describes a circle of radius $\overline{AB}$ and link *4* reciprocates. But when roller *b* comes into contact with cam *6* whose surface *c-c* is a circular arc of radius $\overline{CB}$, link *4* stops. The dwell is determined by working angle α of cam *6*. Roller *b* is held in contact with the cam by spring *5*.



Link *1* is designed as a cam whose working surface *a*-*a* is a circular arc of radius *r*. Cam *1* rolls without slipping along fixed cam *2* whose working surface *b*-*b* is a circular arc of radius *R*. Radii *R* and *r* comply with the condition: $R = 2r$. When cam *1* rolls along cam *2*, points *A* and *B* of cam *1* move along straight lines *x*-*x* and *y*-*y*. Link *3* is connected by turning pair *A* to link *1* and reciprocates in fixed guide *c*. Roller *d*, mounted on pin *B* of link *1*, slides and rolls along fixed slot *e*. Portion BB' of slot *e* is straight and portion $B'B''$ is a circular arc with its centre at A' and of a radius equal to $\overline{AB}$. When point *B* moves to position B', point *A* moves to position A'. At this, roller *f* on pin *A* moves to position f' and enters the fixed seat in guide *c*. When point *B* moves from position B' to position B'', link *1* turns about axis A' and therefore link *3* has a dwell during this period.

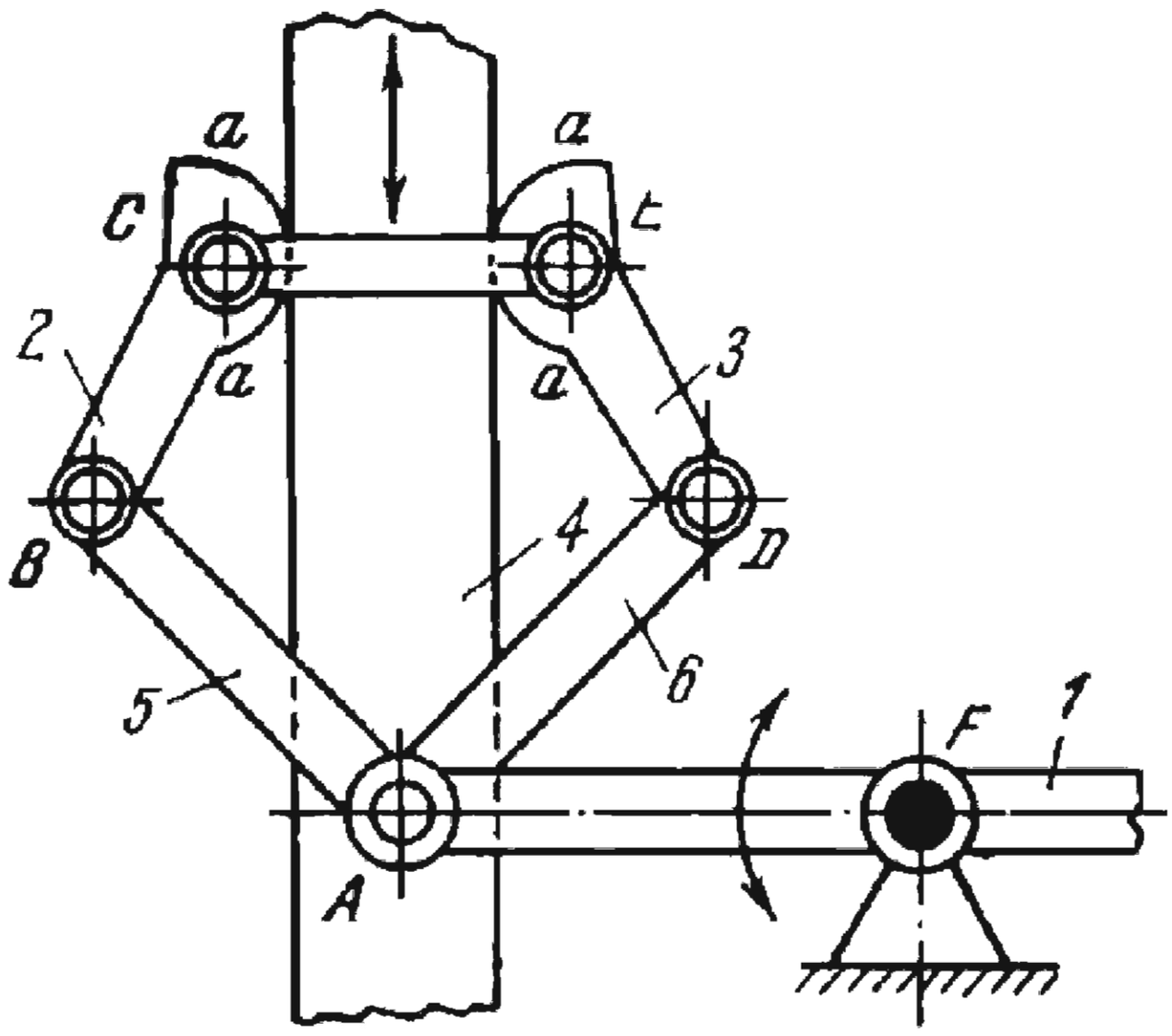
6. GRIPPING, CLAMPING AND EXPANDING MECHANISMS (1704, 1705 and 1706)

1704	LEVER-CAM WIRE GRIPPER	LC GC



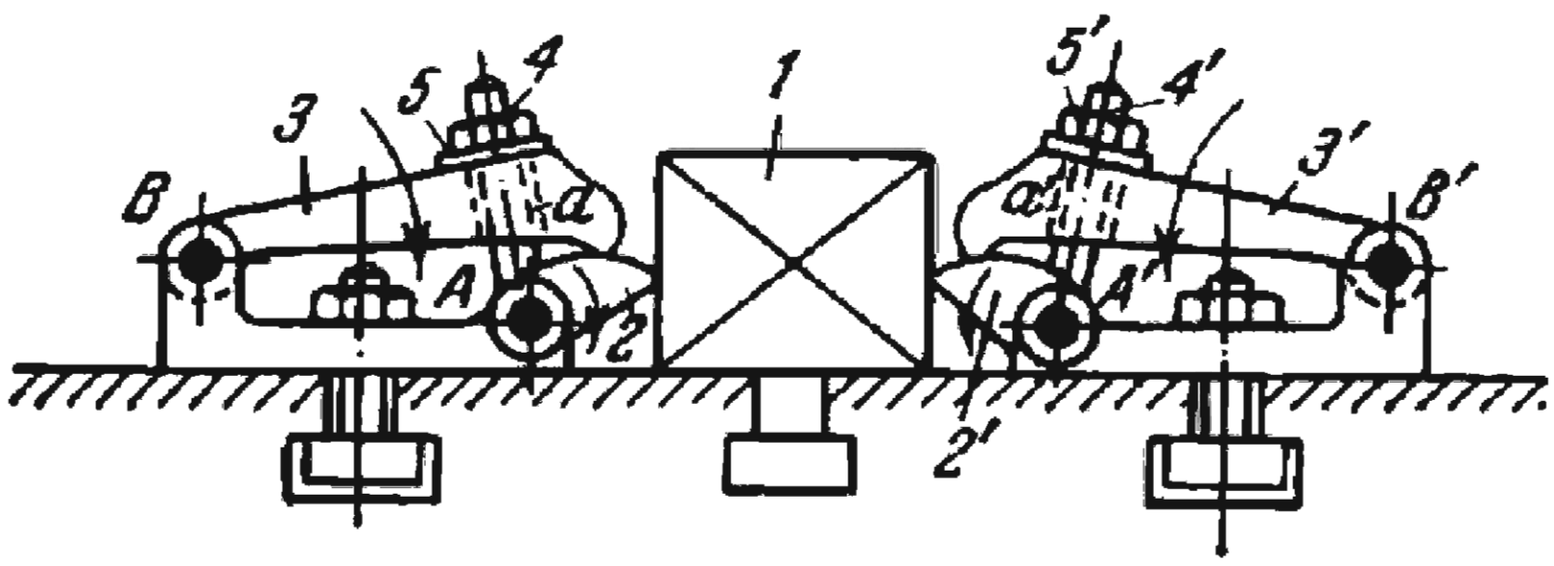
Links *2* and *3* are designed as cams with working surfaces *a-a*. The lengths of the links comply with the conditions: $\overline{AF} = \overline{BE}$ and $\overline{FD} = \overline{ED}$. Thus the upper half of the mechanism is symmetrical to the lower half, thereby ensuring uniform distribution of force *P*, applied at point *C*, over the kinematic pairs. When link is pulled toward the left, levers *2* and *3* turn about points *A* and *B*, and grip the end of wire *4* with the profiled surfaces *a-a*.

1705	LEVER-CAM GRIP	LC GC



Links *2* and *3* are designed as cams with working surfaces *a*-*a*. The lengths of the links comply with the conditions: $\overline{AB} = \overline{AD}$ and $\overline{BC} = \overline{DE}$. When link *1* is turned clockwise about fixed axis *F*, cams *2* and *3* grip plate *4* and advance it. When link *1* is turned in the reverse direction, plate *4* is released.

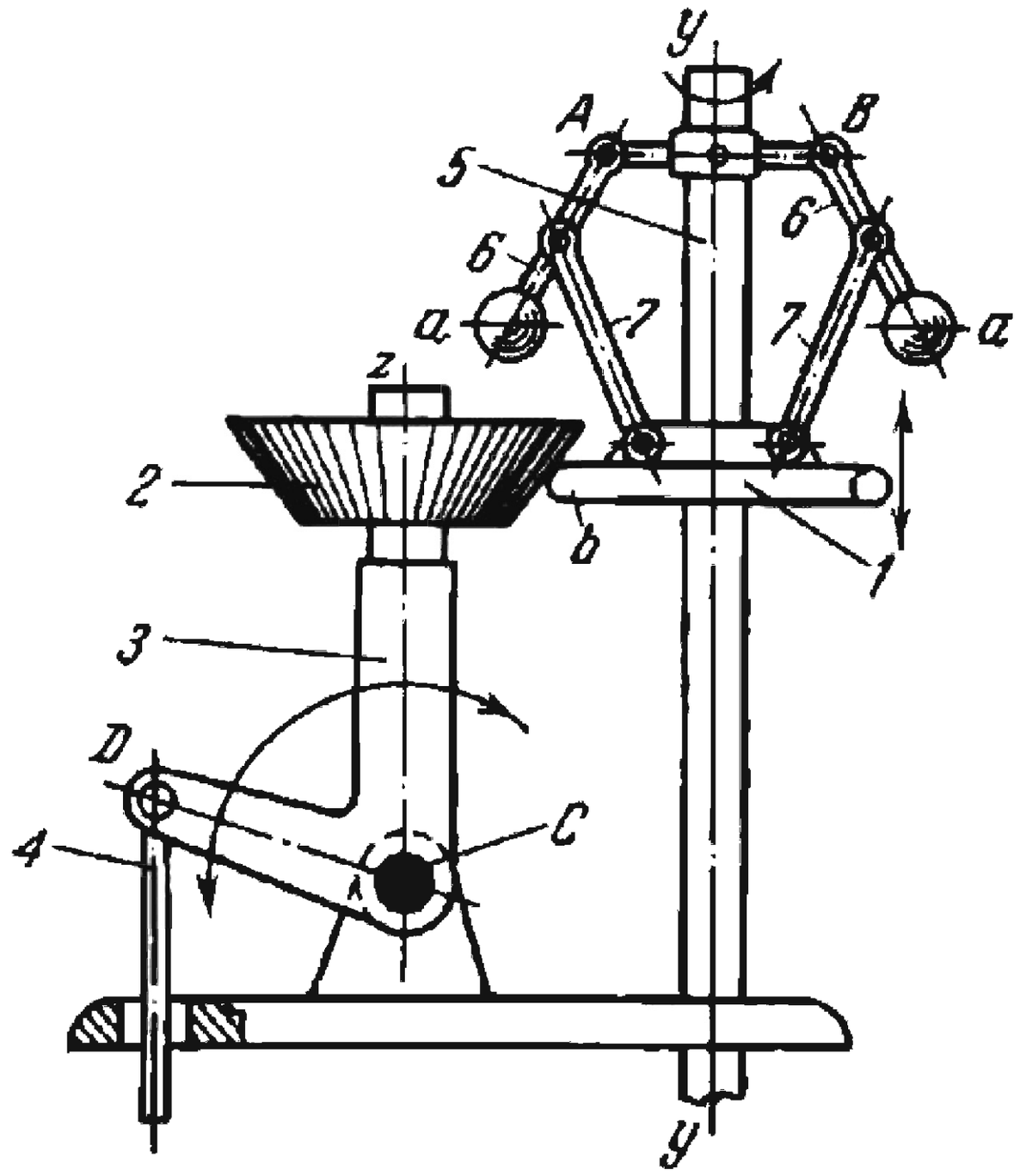
1706	LEVER-CAM CLAMPING MECHANISM	LC GC



Cams *2* and *2′* turn about fixed axes *A* and *A′*. Levers (shaped clamps) *3* and *3′* turn about fixed axes *B* and *B′*. Clamping bolts *4* and *4′* turn about axes *A* and *A′* and pass freely through holes *a* and *a′* in levers *3* and *3′*. When nuts *5* and *5′* are tightened on bolts *4* and *4′*, levers *3* and *3′* bear against cams *2* and *2′* which clamp workpiece *1*.

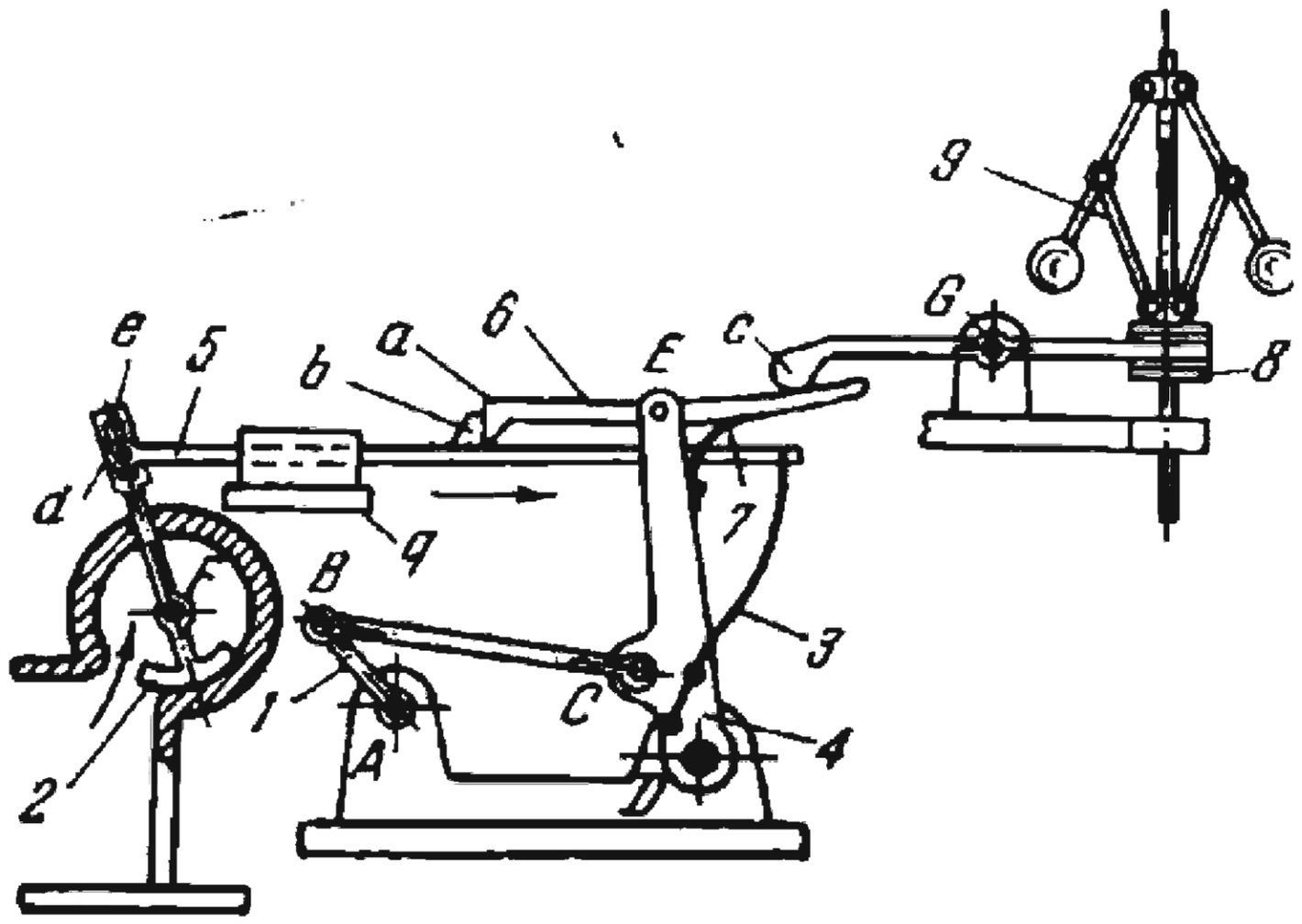
7. GOVERNOR MECHANISMS (1707, 1708 and 1709)

1707	LEVER-CAM MECHANISM OF A CENTRIFUGAL GOVERNOR	LC G



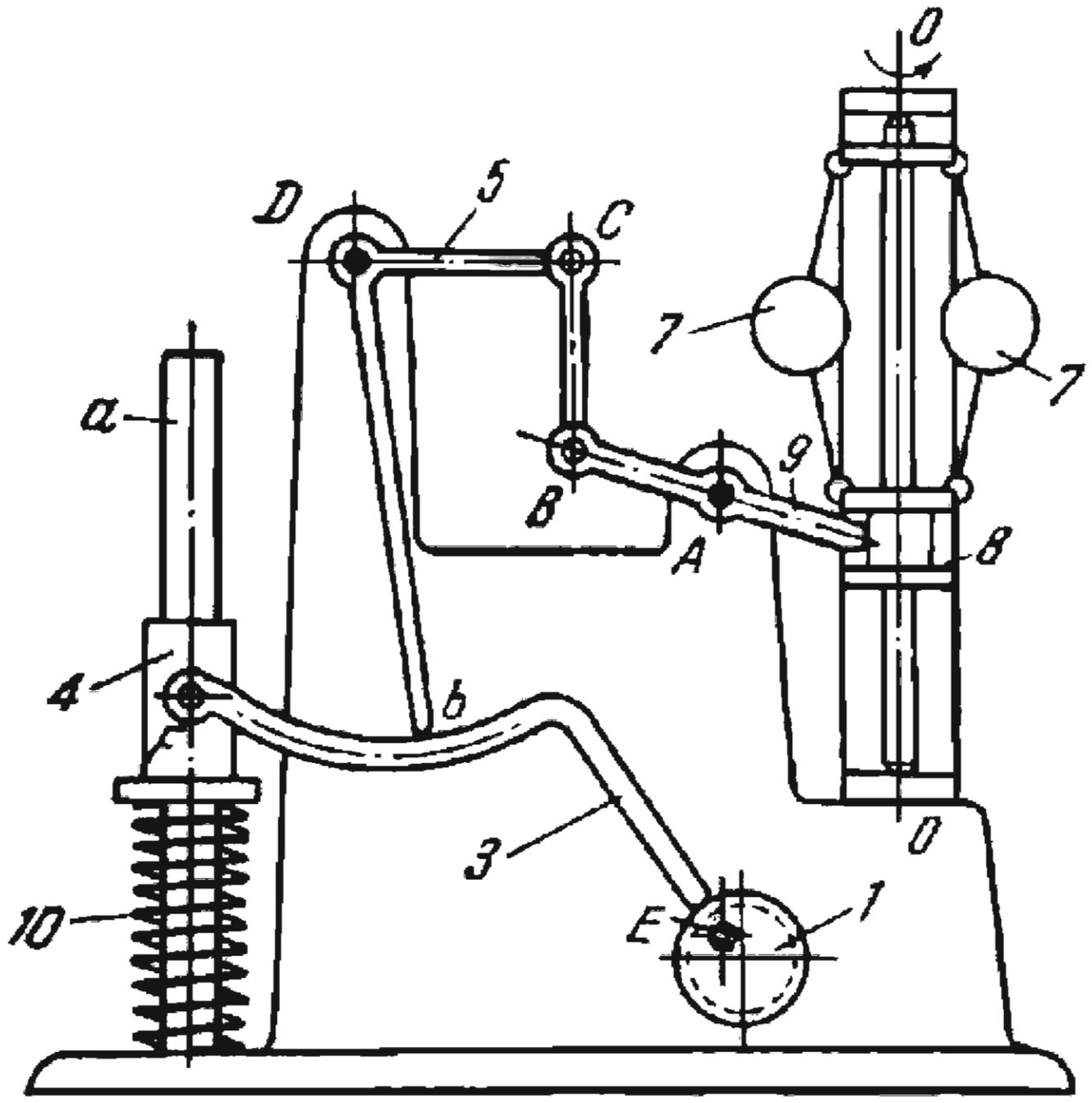
Governor shaft *5* rotates about fixed axis *y-y*. Links *6* with weights *a* turn about axes *A* and *B*. Cross-piece *AB*, levers *6* and *7*, weights *a* and sleeve *1* rotate together with shaft *5*. Intermediate links *7* move sleeve *1* along axis *y-y*. Sleeve *1* has friction disk *b* which engages bevel friction wheel *2*. Wheel *2* rotates freely about axis *z* of lever *3* which turns about fixed axis *C*. Lever *3* is connected by turning pair *D* to tie-rod *4* which is connected to the throttle valve. When the speed of shaft *5* increases, weights *a* are forced outward, shifting sleeve *1* upward. Through bevel wheel *2*, this turns lever *3* counter-clockwise and tie-rod *4* changes the position of the throttle valve.

1708	LEVER-CAM MECHANISM OF A CENTRIFUGAL GOVERNOR	LC G



Link *2* is a shutter and turns about fixed axis *F*. Rod *5* reciprocates in fixed guide *q*. Cam *c* turns about fixed axis *G*. When crank *1* rotates about fixed axis *A*, shutter *2* is oscillated by rod *5* whose pin *d* slides along slot *e* of the shutter. This opens and closes the port through which steam is admitted to the engine cylinder. Motion is transmitted from crank *1* to rod *5* by four-bar linkage *ABCD* through rocker arm *4* and spring *3* when rod *5* moves to the right. Reverse motion is transmitted to rod *5* through lever *6* which oscillates about axis *E* and has lug *a* which, by the action of spring *7*, engages lug *b* on rod *5*. Lever *6* is disengaged from lug *b* by governor *9* whose weights are either forced outward or inward upon changes in speed of the governor spindle. This moves sleeve *8* either upward or downward. The length of time during which lever *6* remains engaged to lug *b* depends upon the position of sleeve *8* and the shape of cam *c*.

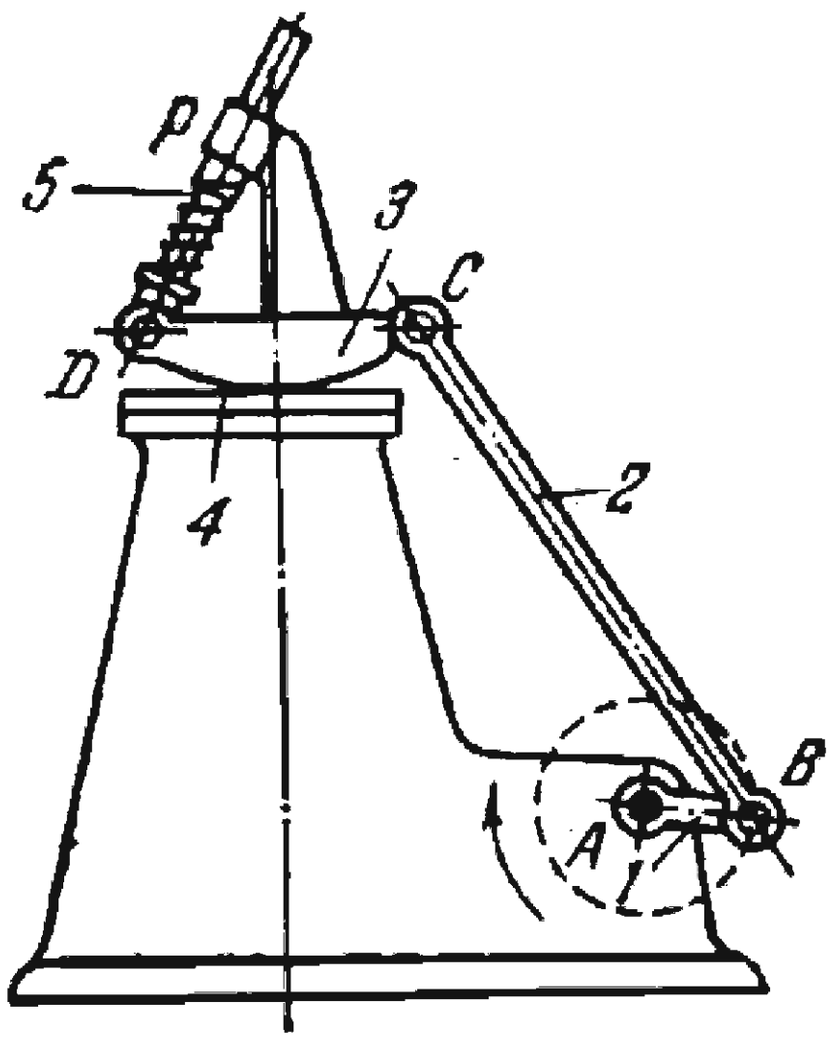
1709	LEVER-CAM MECHANISM OF A CENTRIFUGAL GOVERNOR	LC G



Centrifugal governor *7* moves its sleeve *8* up or down along axis *O-O*, turning lever *9* about fixed axis *A*. Four-bar linkage *ABCD* converts turning motion of lever *9* into turning motion of bent lever *5*. Eccentric *1* rotates about fixed axis *E*, actuating lever *3* which is connected by turning pair *F* to slider *4*. Slider *4* moves along fixed guide *a*. Spring *10* holds lever *3* in contact with lever *5* and eccentric *1*. When eccentric *1* rotates about axis *E*, lever *3* oscillates about the tip *b* of bent lever *5* whose position is determined by centrifugal governor *7*. As a result, slider *4* reciprocates with strokes whose length depends on the angular velocity of the governor.

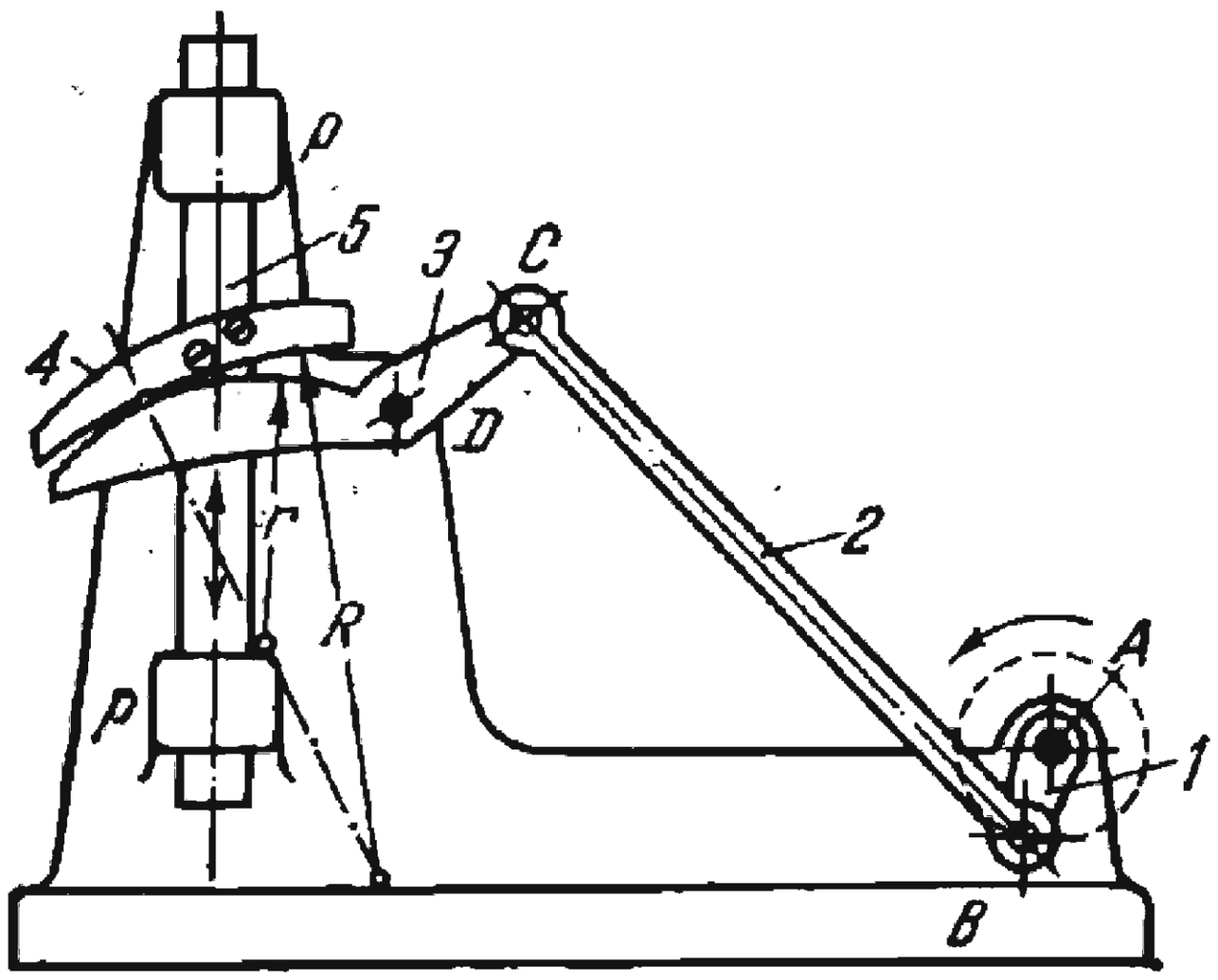
8. ROLLING LEVER MECHANISMS
(1710 through 1724)

1710	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL

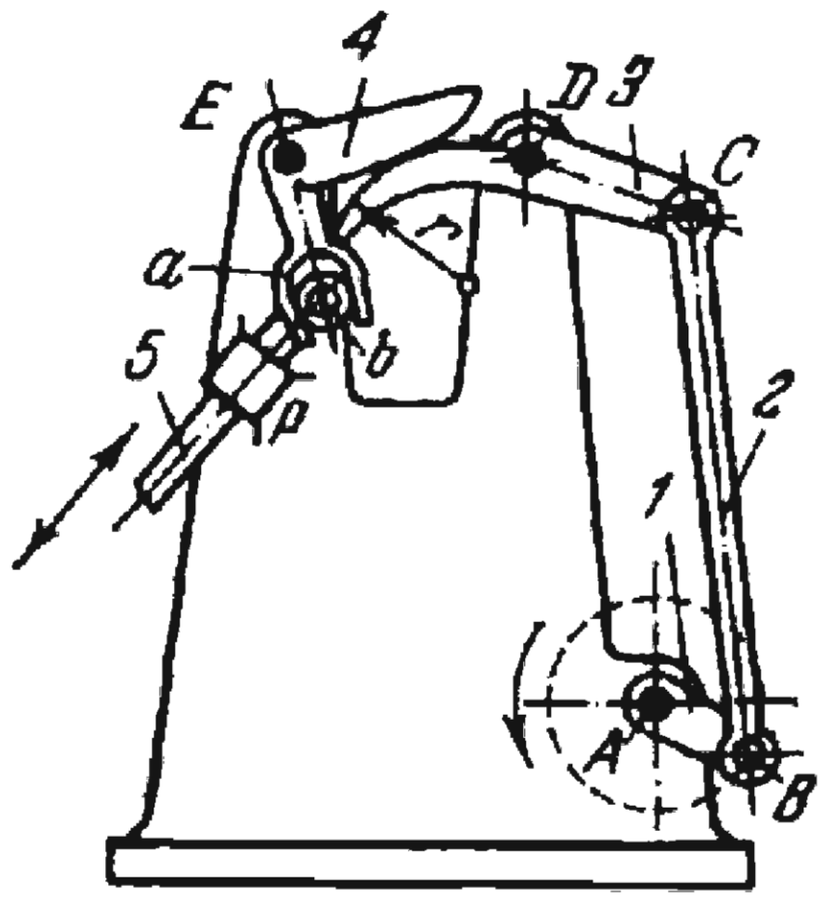


Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* rolls and slides along fixed flat surface *4*. Link *5* slides in fixed guide *p* and is connected by turning pair *D* to lever *3*. Reciprocating motion is transmitted to link *5* by the rolling and sliding motion of lever *3* on flat surface *4*.

1711	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL

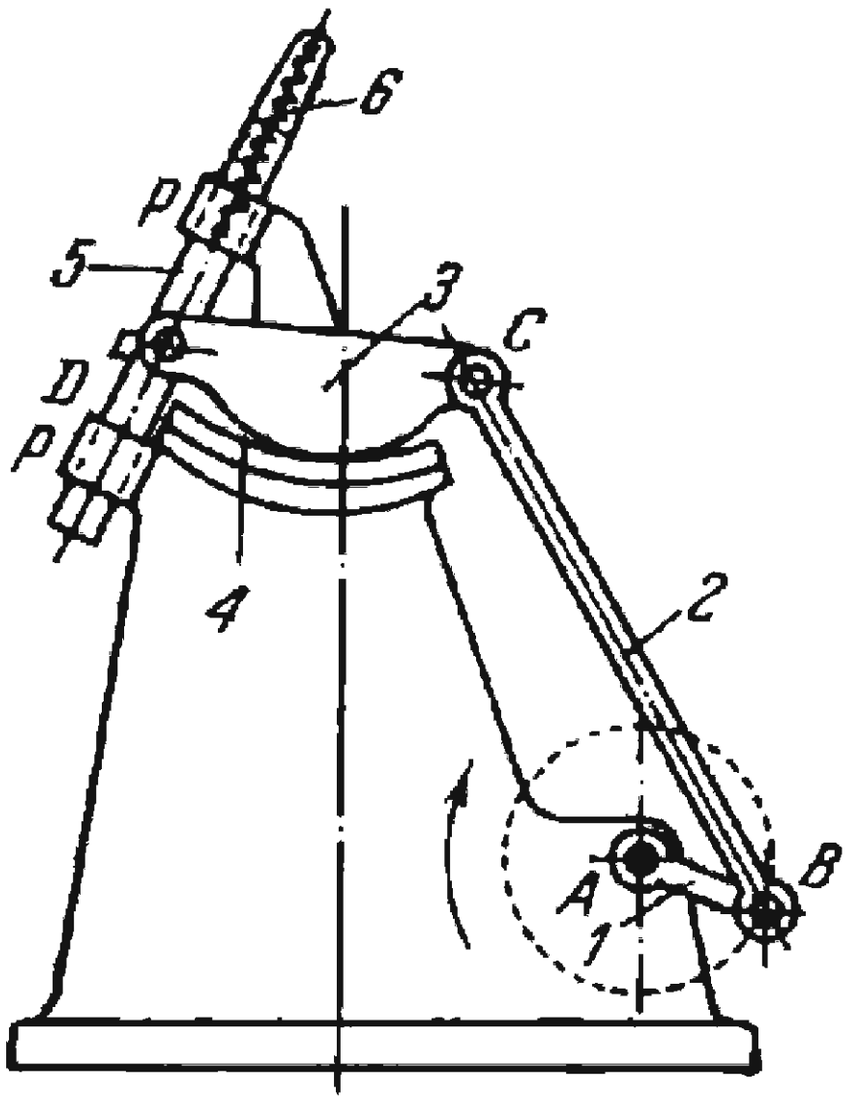


Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* turns about fixed axis *D*. Slider *5* moves in fixed guides *p-p* and has attached lever *4*. Reciprocating motion is transmitted to slider *5* by the rolling motion, without slipping, of lever *3* along lever *4*. The cam surface of lever *3* is along a circular arc of radius *r*; that of lever *4* is a circular arc of radius $R = 2r$.



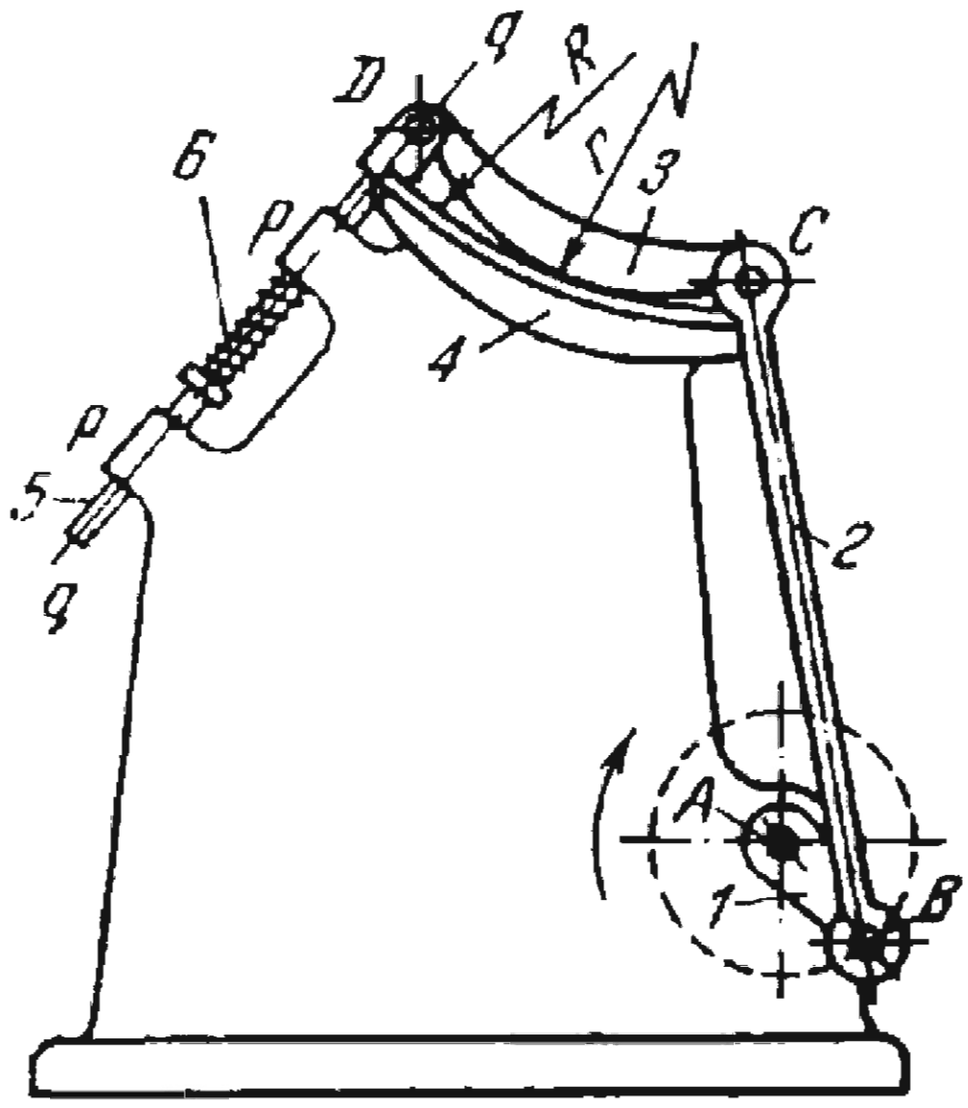
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* turns about fixed axis *D*. Lever *4* turns about fixed axis *E* and has clevis *a* along which roller *b* of link *5* slides. Link *5* slides in fixed guide *p*. The cam surface of lever *3* is along a circular arc of radius *r*. The cam surface of lever *4* is a curve complying with the condition that the levers roll without slipping along each other, i.e. the curve is the centrode of the relative motion of levers *3* and *4*. Reciprocating motion is transmitted to link *5* by the rolling motion, without slipping, of levers *3* and *4* along each other.

1713	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



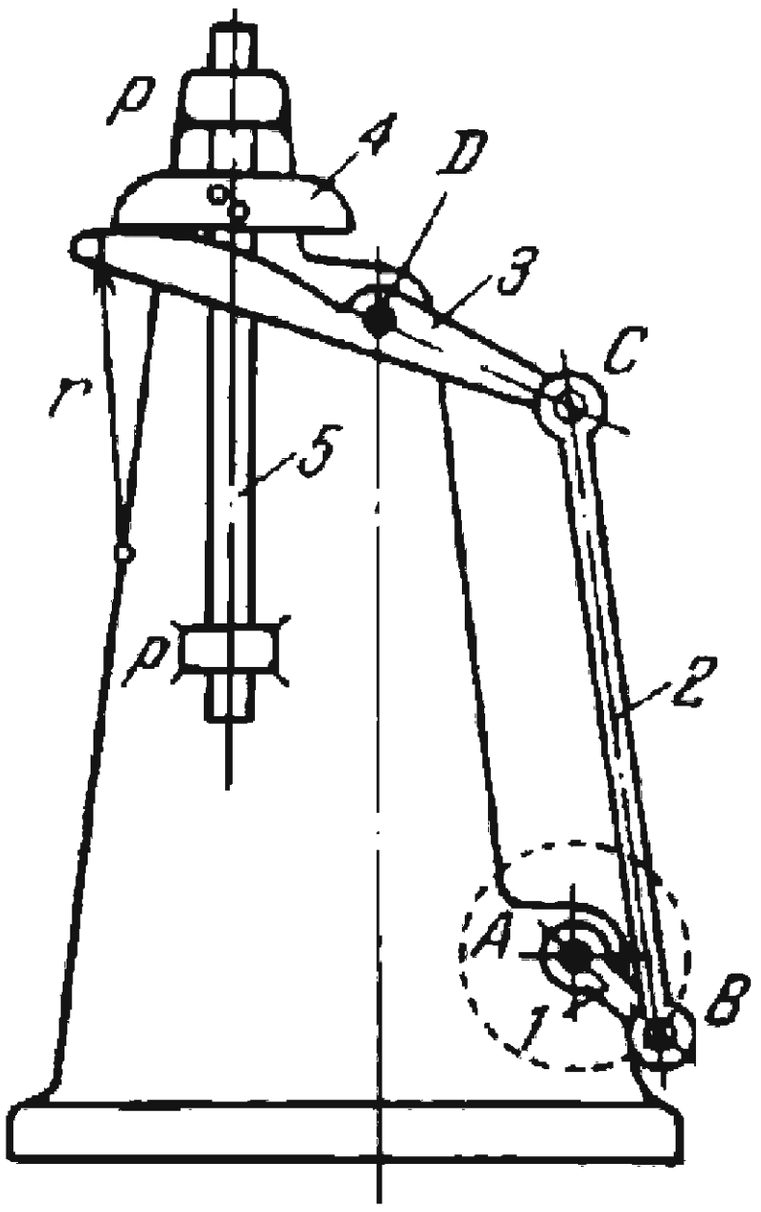
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* rolls and slides along the specially shaped fixed cam surface of link *4*. Lever *3* is connected by turning pair *D* to link *5* which slides in fixed guides *p-p*. When crank *1* rotates about axis *A*, link *5* reciprocates. Spring *6* holds lever *3* in contact with the cam surface of link *4*. The law of reciprocating motion of link *5* depends on the profiles chosen for the cam surfaces of link *4* and lever *3*. Reciprocating motion is transmitted to link *5* by the rolling and sliding motion of the cam surface of lever *3* along the cam surface of fixed link *4*.

1714	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



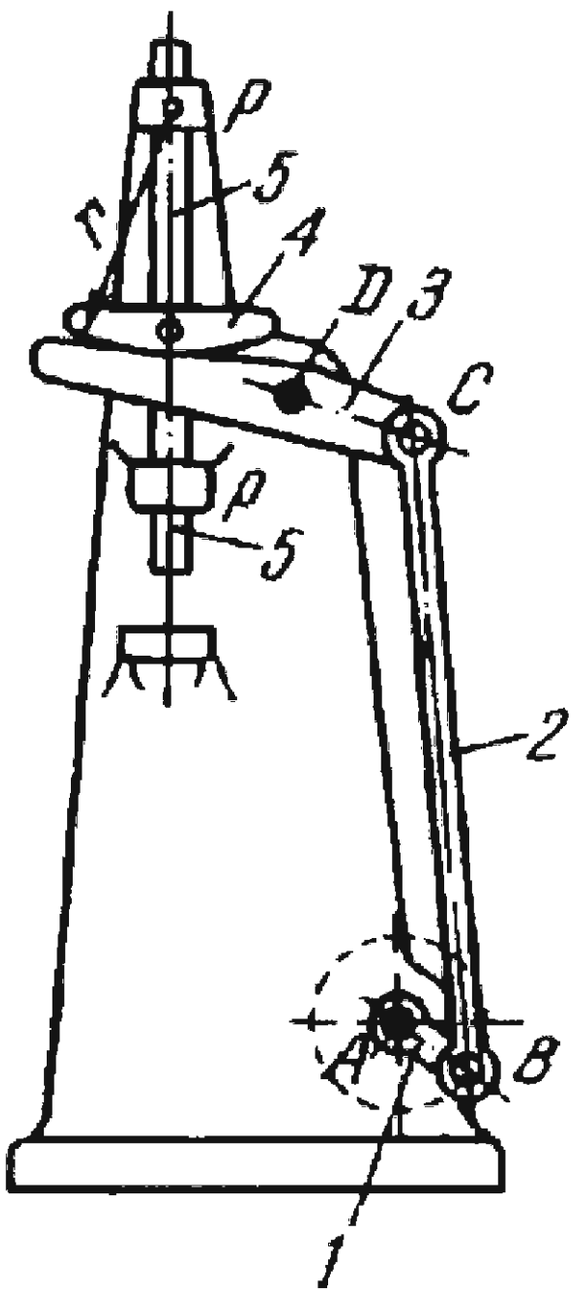
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. The cam surface of lever *3* is a circular arc of radius *r*. Lever *3* rolls along fixed link *4* whose cam surface is a circular arc of radius $R = 2r$. Lever *3* is connected by turning pair *D* to link *5* which slides in fixed guides *p-p*. Spring *6* holds lever *3* in contact with the cam surface of link *4*. The cam surfaces of lever *3* and link *4* are designed so that point *D*, lying on the circle of radius *r*, always moves in a straight line along axis *q-q* which passes through the centre of the circle. Thus the rolling of a circle of radius *r* along a circle of radius *R* is the so-called motion of the Cardan circles. Reciprocating motion is transmitted to link *5* by the rolling motion of lever *3* along the cam surface of fixed link *4*.

1715	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



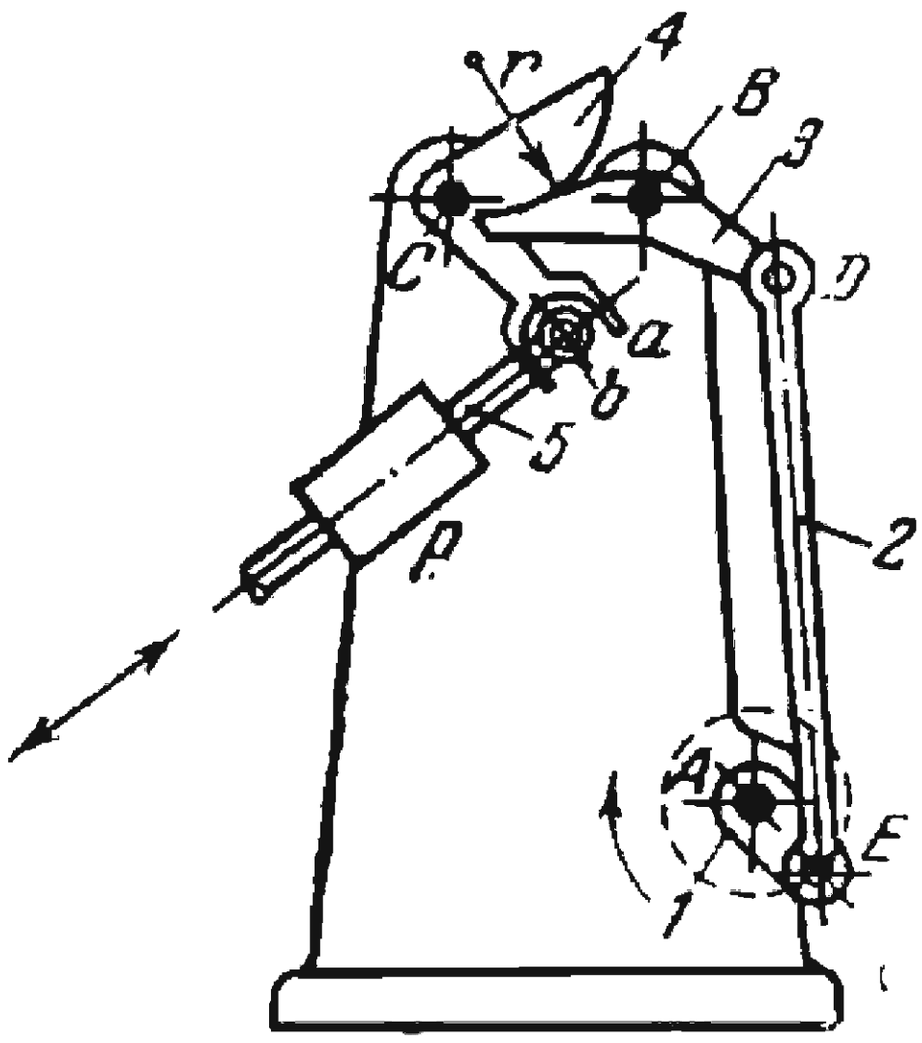
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* turns about fixed axis *D*. Link *5* slides in fixed guides *p-p* and carries rigidly attached lever *4*. Reciprocating motion is transmitted to link *5* by the rolling and sliding motion of the cam surface of lever *3* along the cam surface of lever *4*. The cam surface of lever *3* is along a circular arc of radius *r*; that of lever *4* is along a straight line.

1716	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



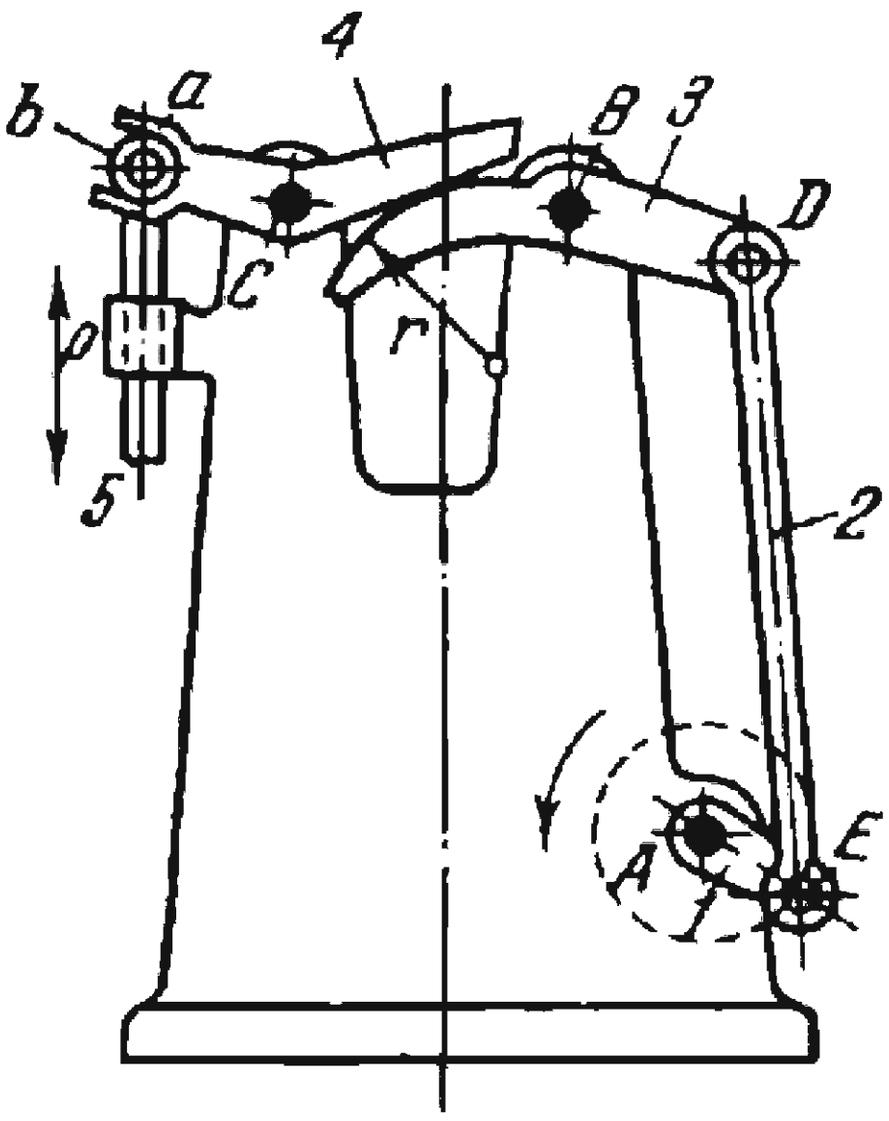
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* turns about fixed axis *D*. Link *5* slides in fixed guides *p-p* and carries rigidly attached lever *4*. Reciprocating motion is transmitted to link *5* by the rolling and sliding motion of the cam surface of lever *3* along the cam surface of lever *4*. The cam surface of lever *3* is along a straight line; that of lever *4* is along a circular arc of radius *r*.

1717	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



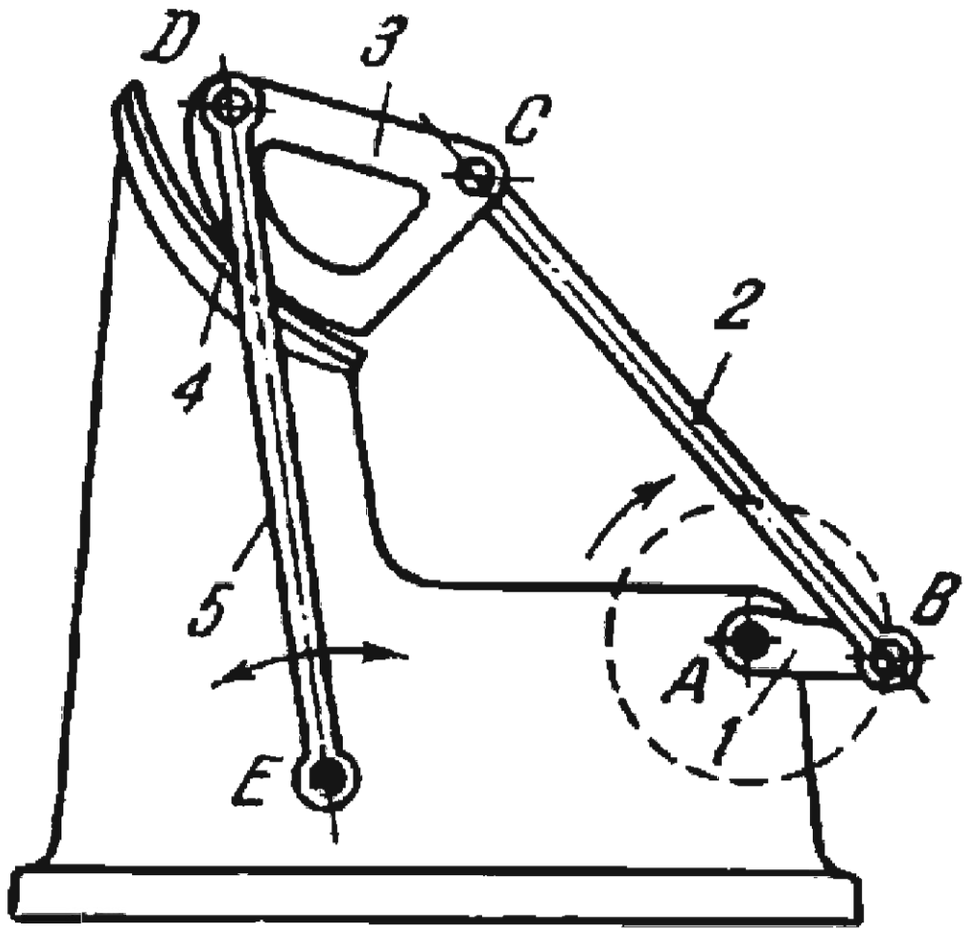
Crank *1* rotates about fixed axis *A* and is connected by turning pair *E* to connecting rod *2* which, in turn, is connected by turning pair *D* to lever *3*. Lever *3* turns about fixed axis *B*. Lever *4* turns about fixed axis *C* and has clevis *a* along which roller *b* of link *5* slides. Link *5* slides in fixed guide *p*. Reciprocating motion is transmitted to link *5* by the rolling and sliding motion of the cam surface of lever *3* along the cam surface of lever *4*. The cam surface of lever *3* is along a straight line; that of lever *4* is along a circular arc of radius *r*.

1718	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



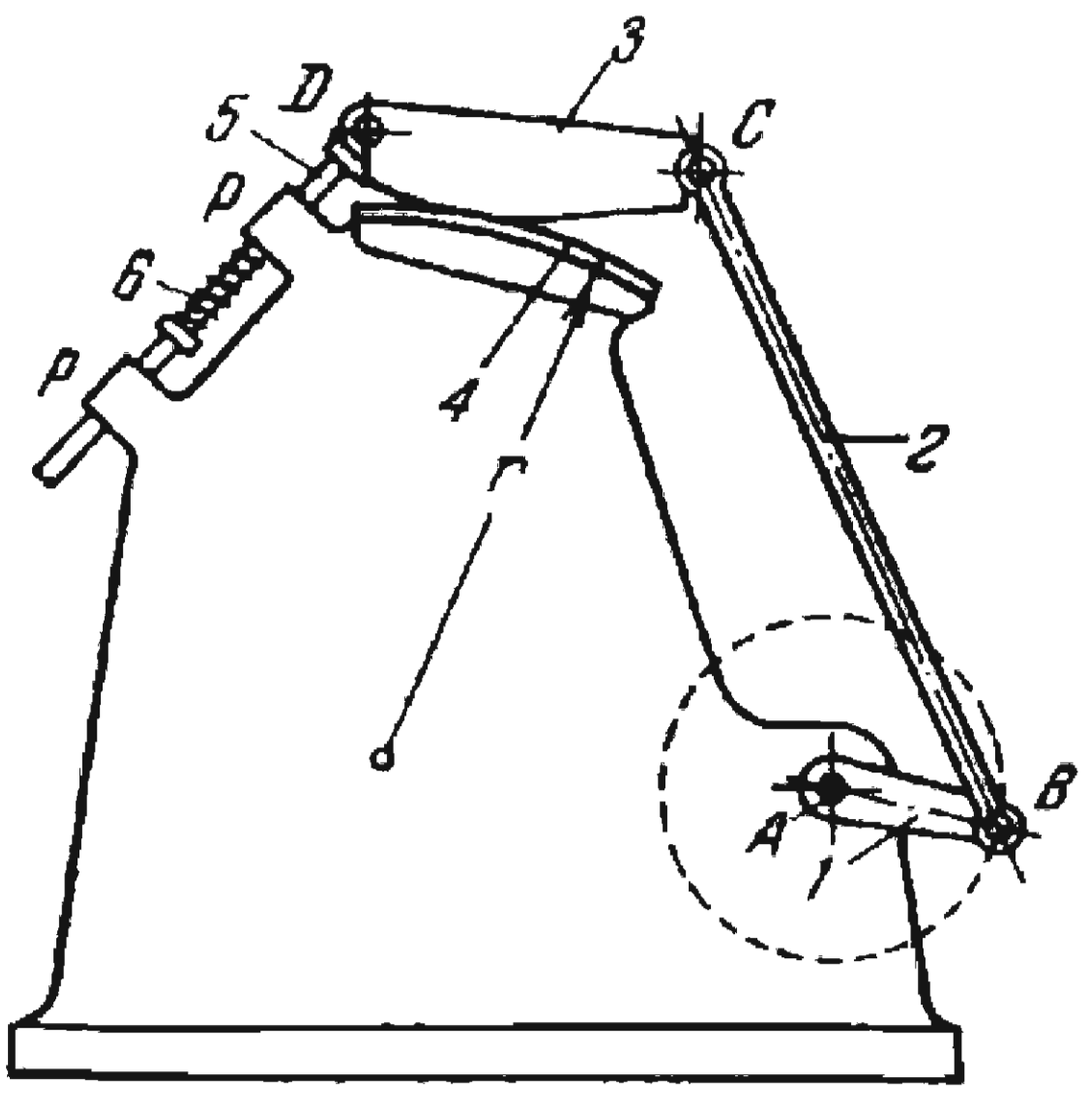
Crank *1* rotates about fixed axis *A* and is connected by turning pair *E* to connecting rod *2* which, in turn, is connected by turning pair *D* to lever *3*. Lever *3* turns about fixed axis *B*. Lever 4 turns about fixed axis *C* and has clevis *a* along which roller *b* of link *5* slides. Link *5* slides in fixed guide *p*. Reciprocating motion is transmitted to link *5* by the rolling and sliding of the cam surface of lever *3* along the cam surface of lever *4*. The cam surface of lever *3* is along a circular arc of radius *r*; that of lever *4* is along a straight line.

1719	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



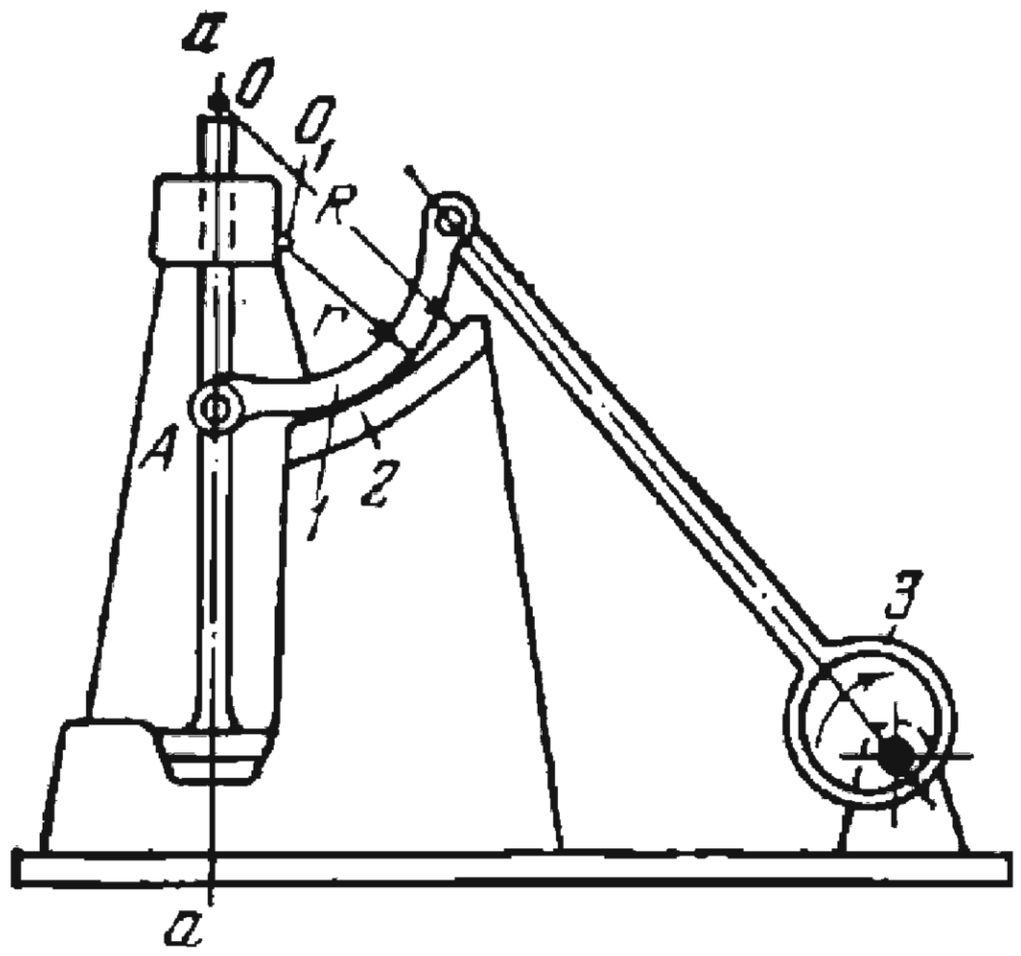
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever *3*. Lever *3* rolls and slides along fixed link *4* whose cam surface is a circular arc. Lever *3* is connected by turning pair *D* to lever *5* which turns about fixed axis *E*. When crank *1* rotates about axis *A*, lever *5* oscillates about axis *E*. The law of motion of lever *5* depends upon the profile chosen for the cam surface of lever *3*.

1720	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



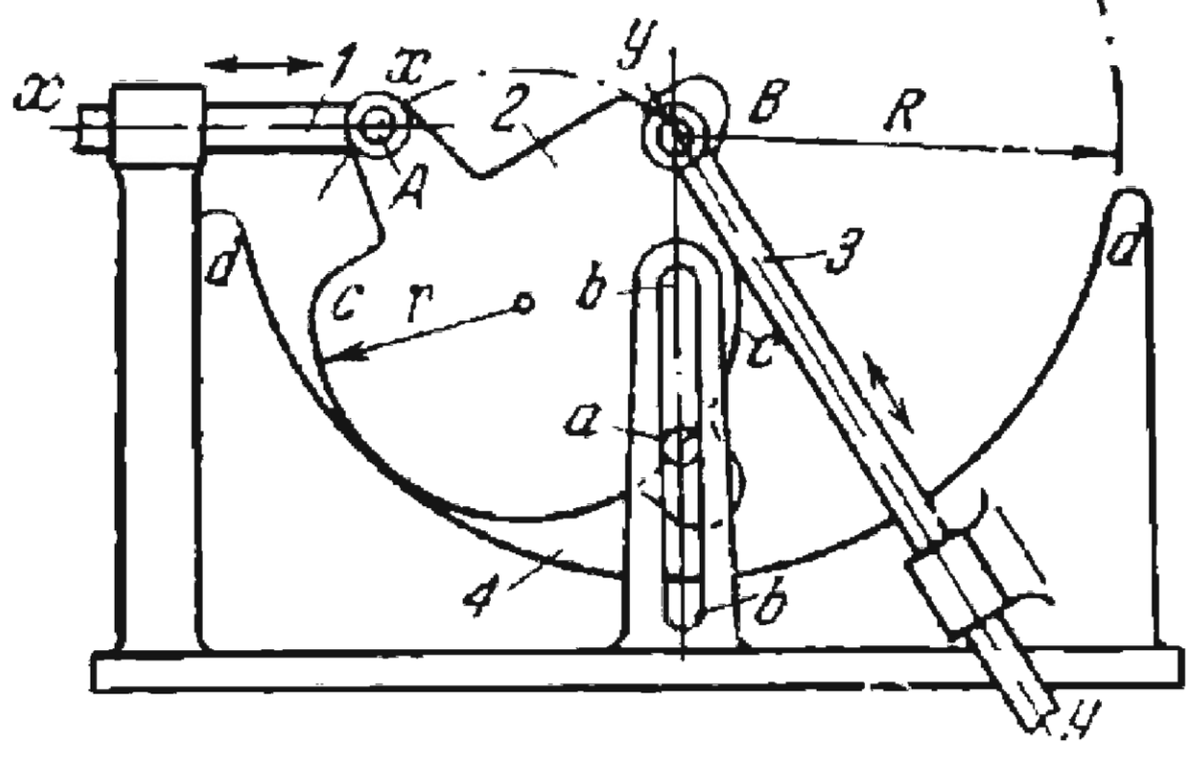
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2* which, in turn, is connected by turning pair *C* to lever 3. Lever *3* rolls and slides with its cam surface along fixed link *4* whose cam surface is along a circular arc of radius *r*. Lever *3* is connected by turning pair *D* to link *5* which slides in fixed guides *p*-*p*. When crank *1* rotates about axis *A*, link *5* reciprocates in guides *p*-*p*. Spring *6* holds lever *3* in contact with the cam surface of link *4*. The law of motion of link *5* depends upon the profile chosen for the cam surface of lever *3*.

1721	LEVER-CAM ECCENTRIC ROLLING-LEVER MECHANISM	LC RL



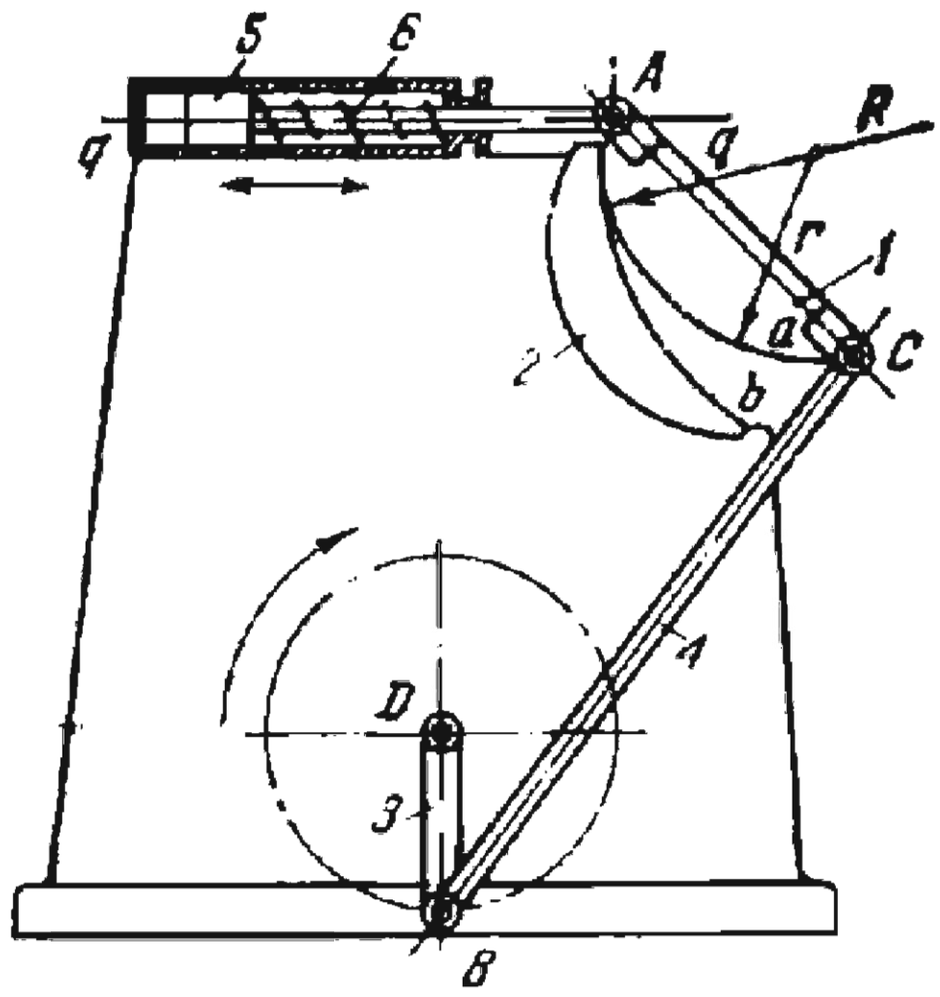
The profile of lever *1* is along a circular arc of radius *r*. The profile of fixed link *2* is along a circular arc of radius *R*. If $R = 2r$, then point *A* always moves along straight line *a-a*. Lever *1* rolls without slipping with its cam surface along the cam surface of link *2*. The mechanism is driven by eccentric *3*.

1722	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



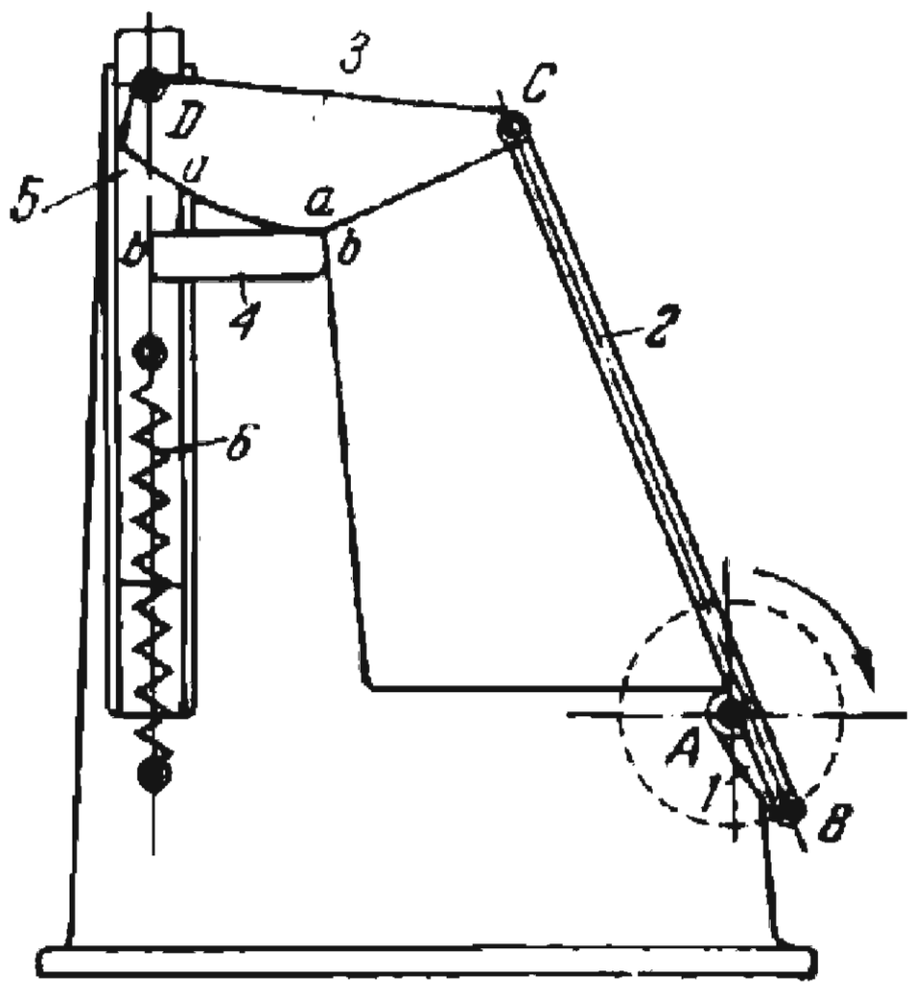
Link *2* is designed as a cam whose profile *c-c* is along a circular arc of radius *r*. Cam *2* rolls without slipping along fixed cam *4* whose profile is along a circular arc of radius *R*. Pin *a* of cam *2* slides along fixed guides *b-b*. The centre of pin *a* lies on circular arc *c-c*. If radius $R = 2r$, then any point of link *2* lying on circular arc *c-c* moves along a straight line passing through the centre of circular arc *d-d*. Thus the mechanism converts translational motion of link *1* along axis *x-x* into translational motion of link *3* along axis *y-y* making an arbitrary angle with axis *x-x*.

1723	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



Crank *3* rotates about fixed axis *D*. Link *4* is connected by turning pairs *B* and *C* to links *3* and *1*. Link *1* is designed as a cam whose profile *a* is along a circular arc of radius *r*. Cam *1* rolls without slipping along the surface of fixed cam *2* whose profile is along a circular arc of radius *R*. If radius $R = 2r$, then point *A*, lying on arc *a*, moves along straight line *q-q*, transmitting reciprocating motion to piston *5*. Spring *6* holds cam *1* in contact with cam *2*.

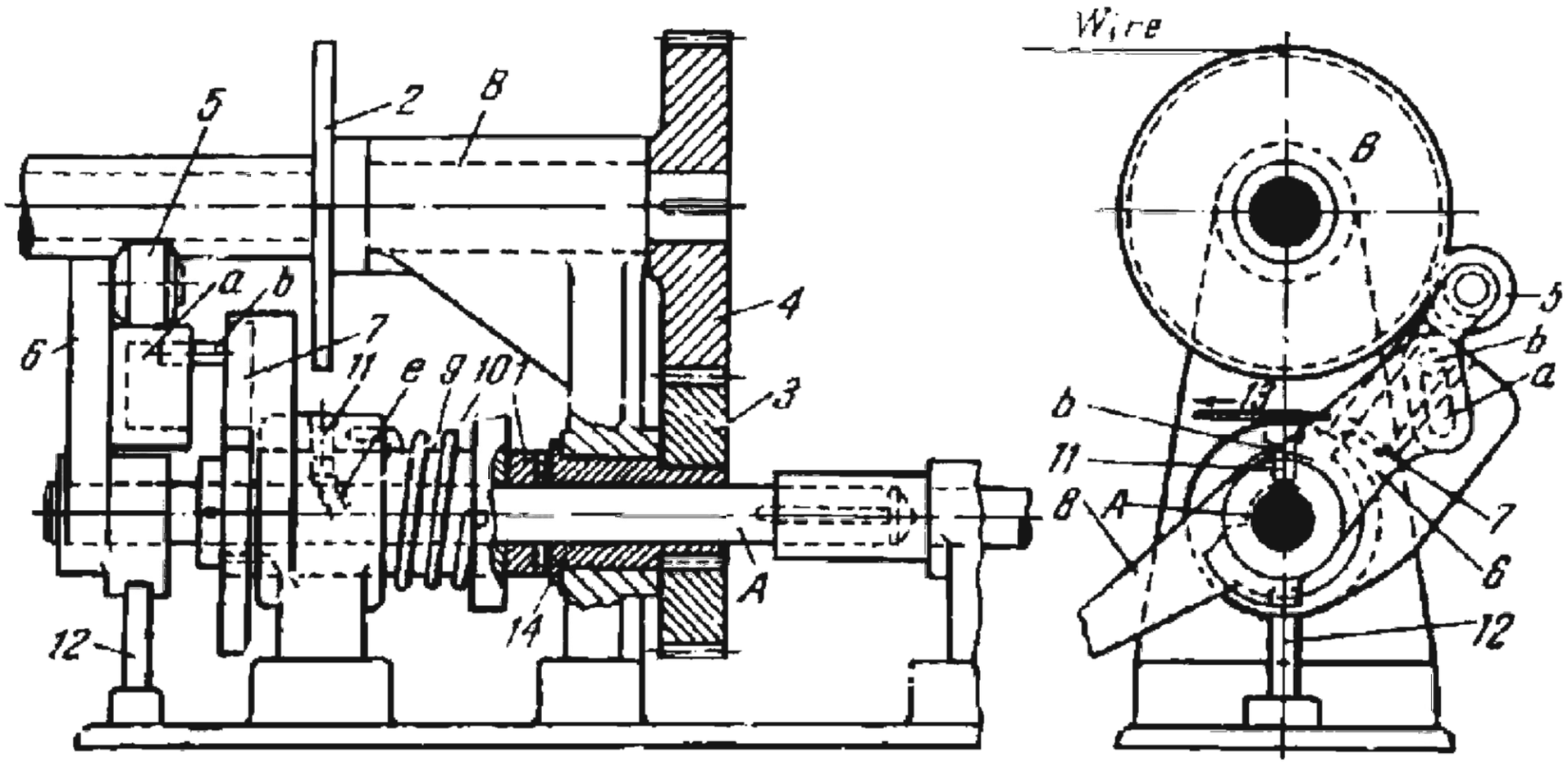
1724	LEVER-CAM ROLLING-LEVER MECHANISM	LC RL



Crank *1* rotates about fixed axis *A*. Link *2* is connected by turning pairs *B* and *C* to links *1* and *3*. Link *3* is designed as a cam with profile *a-a*. Cam *3* rolls and slides along fixed cam *4* whose profile *b-b* is along a straight line. Link *5* reciprocates in fixed guides. Spring *6* holds cam *3* in contact with cam *4*. The law of motion of link *5* depends upon the shape of profile *a-a* on cam *3*.

9. STOP, DETENT AND LOCKING MECHANISMS (1725)

1725	LEVER-CAM AUTOMATIC STOP MECHANISM	LC SD



Rotation is transmitted from shaft *A* to shaft *B* as follows. Clutch member *1*, shrink-fitted on shaft *A*, engages the clutch teeth of sleeve *14* on which gear *3* is keyed. Gear *3* meshes with gear *4* which is keyed on shaft *B*. Secured on shaft *B* is reel *2* on which wire is being wound. As wire reel *2* becomes filled and due to its increasing diameter, roll *5*, resting on the layers of wire, is gradually forced outward so that its lever *6* is turned clockwise. At this, slot *a* of lever *6* pushes pin *b* with latch *7* upwards with respect to its fixed guide. As soon as latch *7* is disengaged from hand-lever *8*, secured to sleeve *9*, the lever and sleeve begin to turn clockwise by the action of torsion spring *10*. Since sleeve *9* has helical cam slot *e*, it is shifted to the left when turned clockwise. This disengages clutch members *1* and *14* and shaft *B* stops. After the full reel is removed and replaced by an empty one, hand-lever *8* is turned downward (counterclockwise). This advances roll *5* to the core of the reel so that slot *a* allows pin *b* to move downward and latch *7* again engages the projection of hand-lever *8*, locking the lever in position. The downward movement of hand-lever *8* also turns sleeve *9* which, due to the reverse action of pin *11* in cam slot *e*, is shifted to the right re-engaging clutch members *1* and *14* so that rotation is again transmitted to reel *2*. Roll *5* is held in contact with the layers of wire by a weight pulling cable *13* to the left. Lever *6* turns freely on drive shaft *A* and is prevented from moving axially by fixed pin *12*.

10. MECHANISMS OF MEASURING AND TESTING DEVICES (1726, 1727 and 1728)

1726	LEVER-CAM MECHANISM FOR ZEROING A REVOLUTION COUNTER	LC M

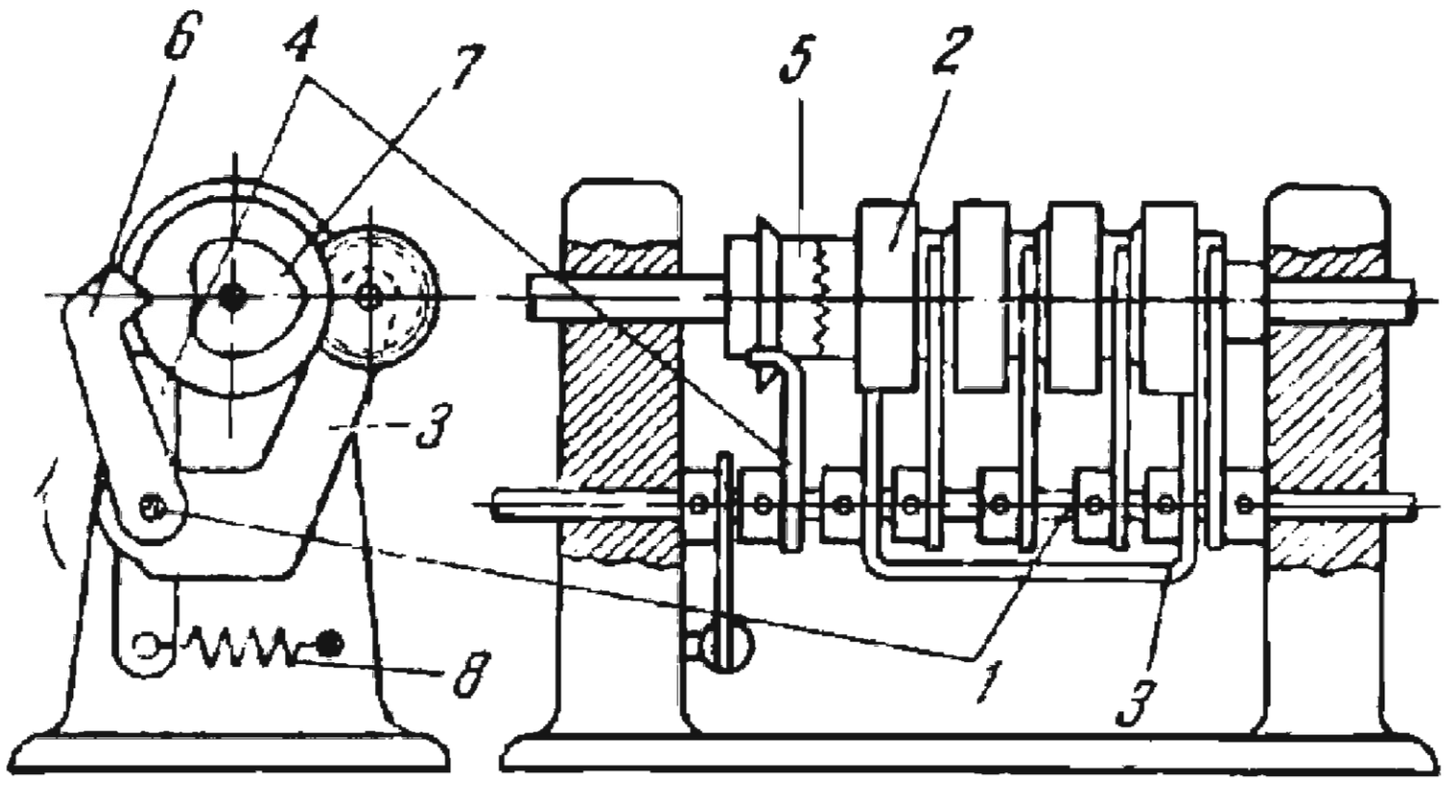
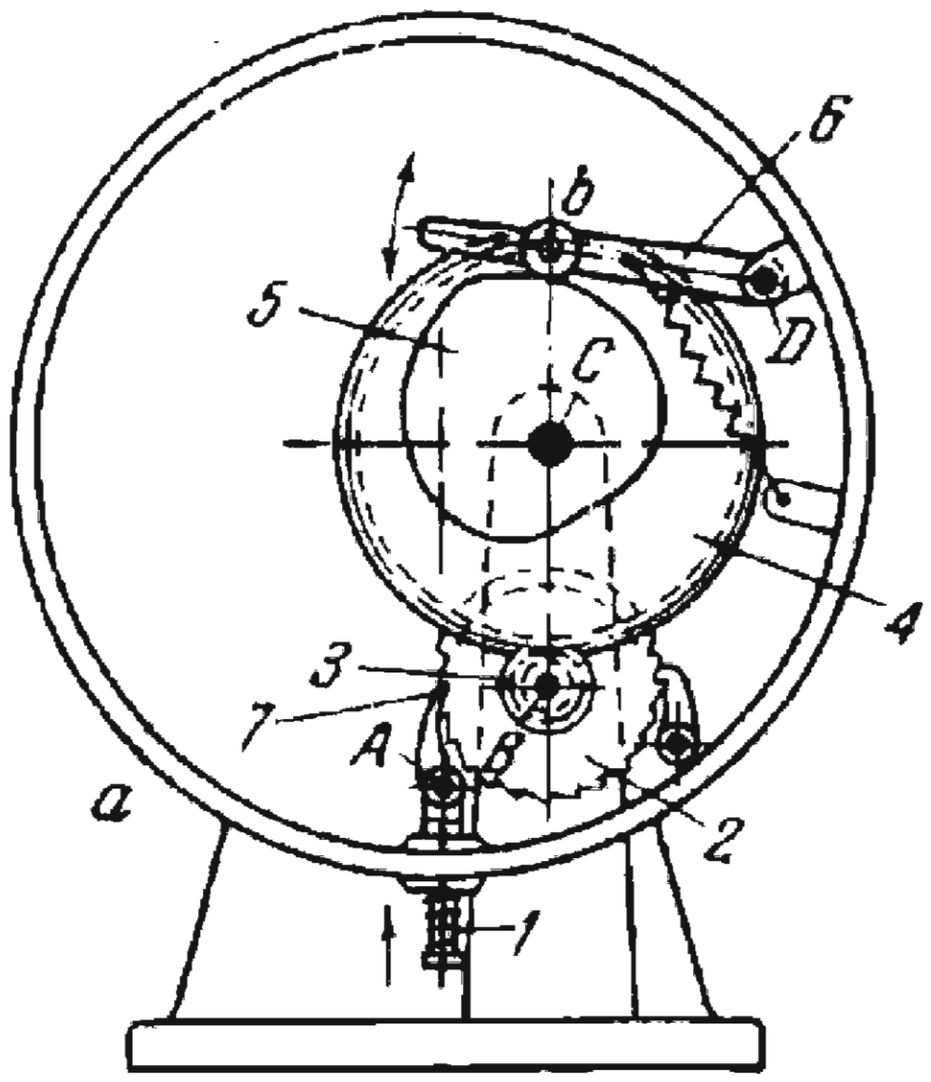


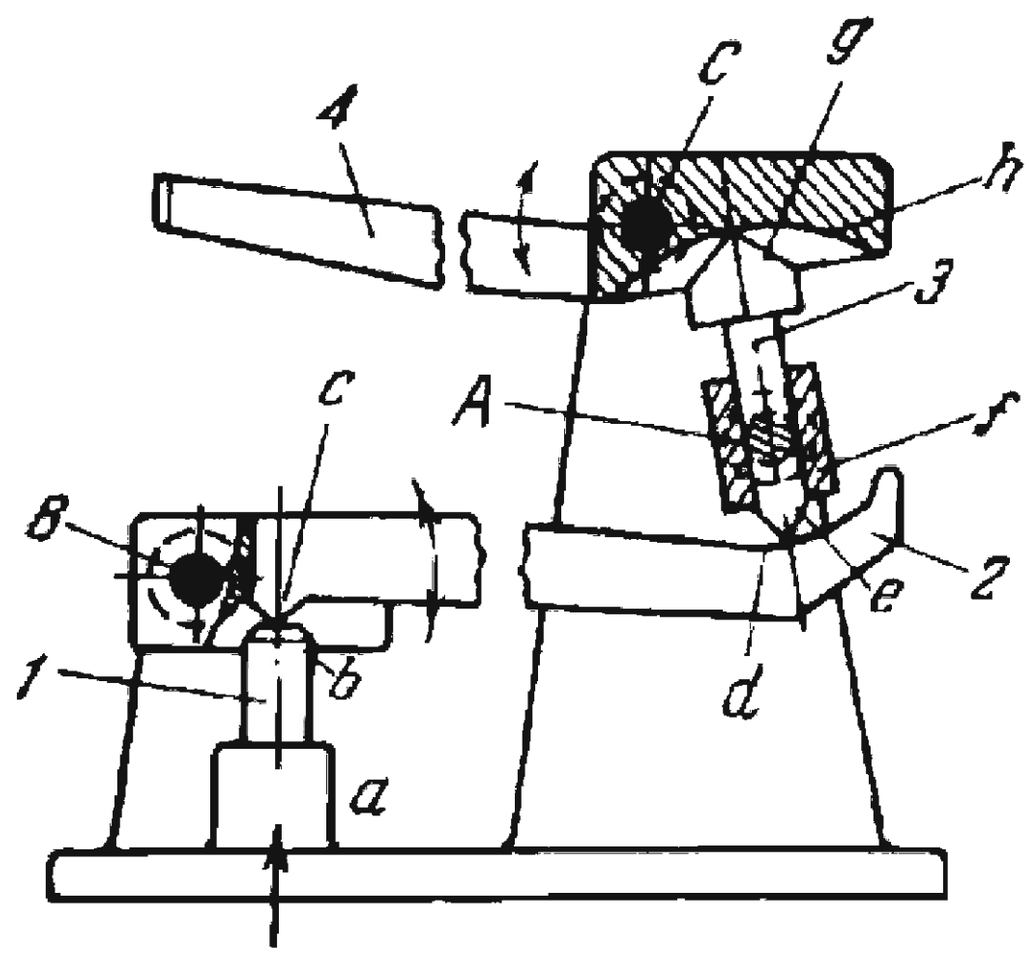
Figure wheels (drums) *2* are set to zero by turning shaft *1* clockwise. This also turns frame *3*, secured on shaft *1*, thereby disengaging the drive gears of the counter. At the same time, lever *4*, having a bevelled end, disengages toothed clutch *5*. Then lever *6* actuates cam *7* to set the figure drums to zero. Spring *8* returns shaft *1* and the levers mounted on it to their initial positions.

1727	LEVER-CAM COUNTER MECHANISM	LC M



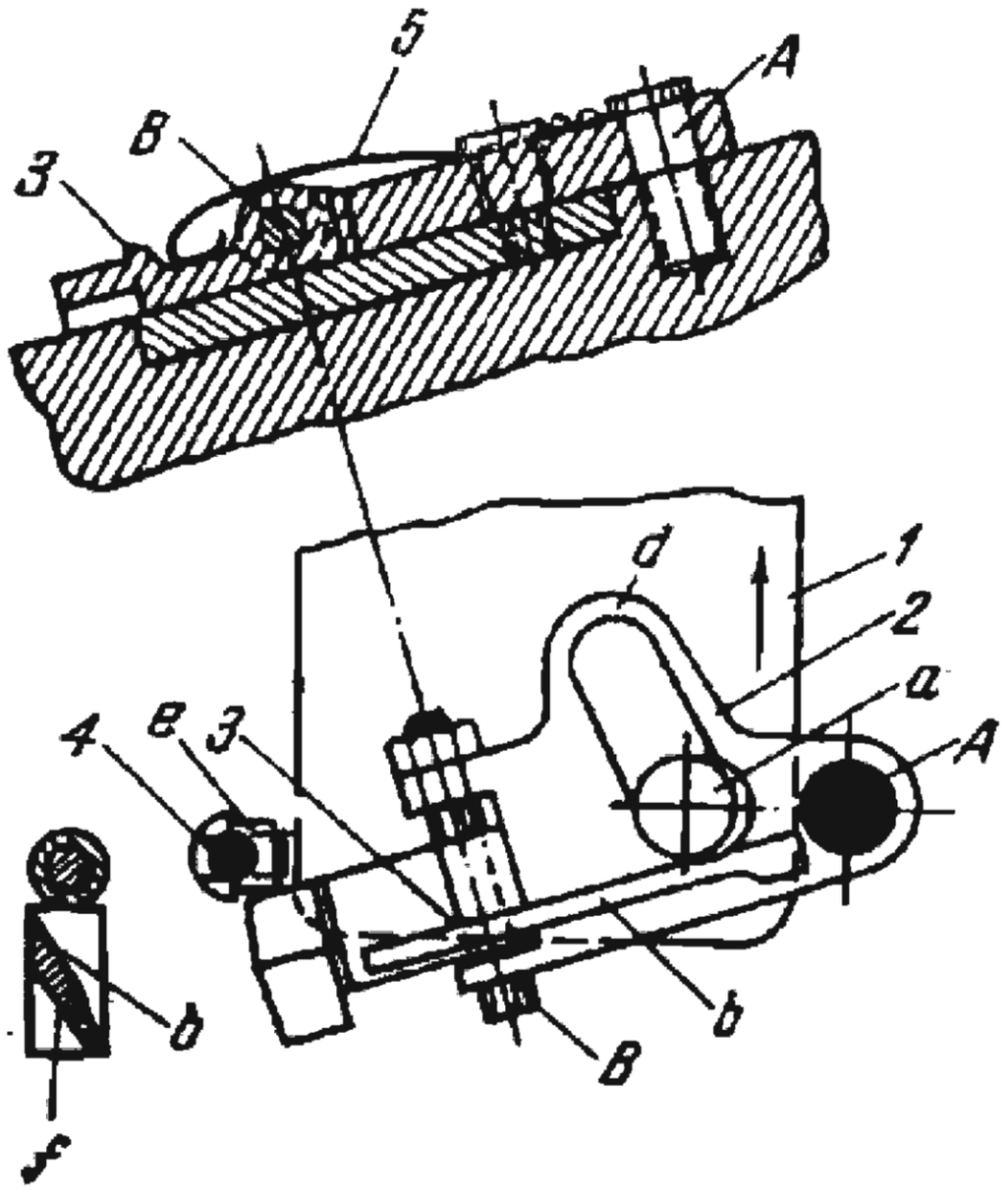
Link *1* reciprocates in housing *a* and is connected by turning pair *A* to pawl *7*. Ratchet wheel *2* and pinion *3* are rigidly fastened together and rotate about fixed axis *B*. Gear *4* and cam *5* rotate about fixed axis *C*. Lever *6* turns about fixed axis *D* and has roll *b* which is the follower of cam *5*. The motion of link *1* is transmitted through ratchet wheel *2*, pinion *3* and gear *4* to cam *5* which is rigidly attached to gear *4*. Cam *5* oscillates lever *6* which registers the number of strokes of link *1*.

1728	LEVER-CAM INDICATOR MECHANISM	LC M



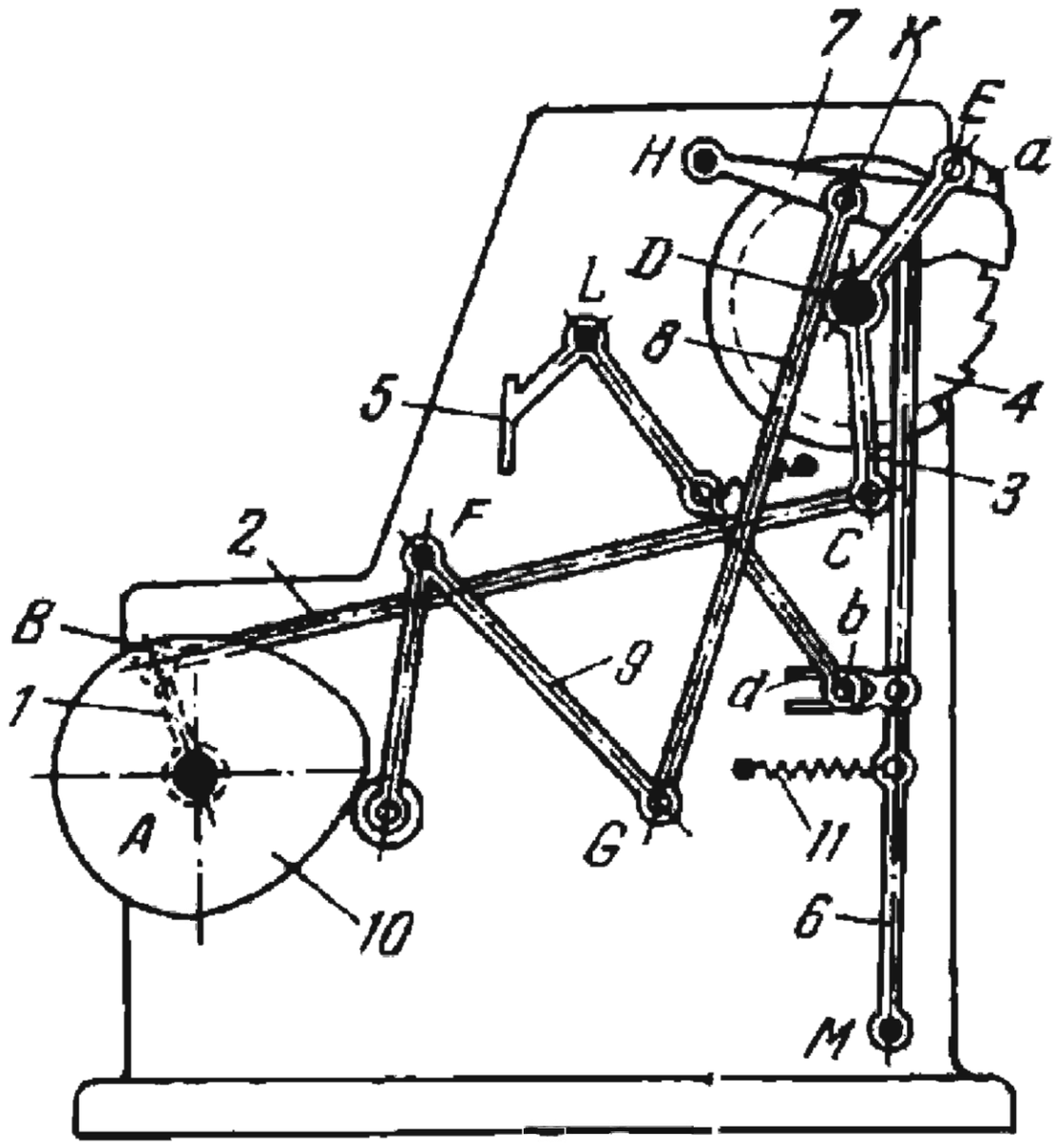
Plunger *1* slides in fixed guide *a* and its tip *b* slides along lug *c* of lever *2* which turns about fixed axis *B*. The cam surface *d* at the right end of lever *2* slides along point *e* of link *3* which slides in fixed guide *f*. Point *g* of link *3* slides along cam surface *h* of lever *4* which turns about fixed axis *C*. The motion of link *1* is transmitted by links *2*, *3* and *4* to a hand (not shown) which is rigidly attached to lever *4*. For adjustment, guide *f* of link *3* can be turned as required about fixed axis *A* and clamped in the required position.

1729	LEVER-CAM TABLE SWIVEL MECHANISM	LC FD



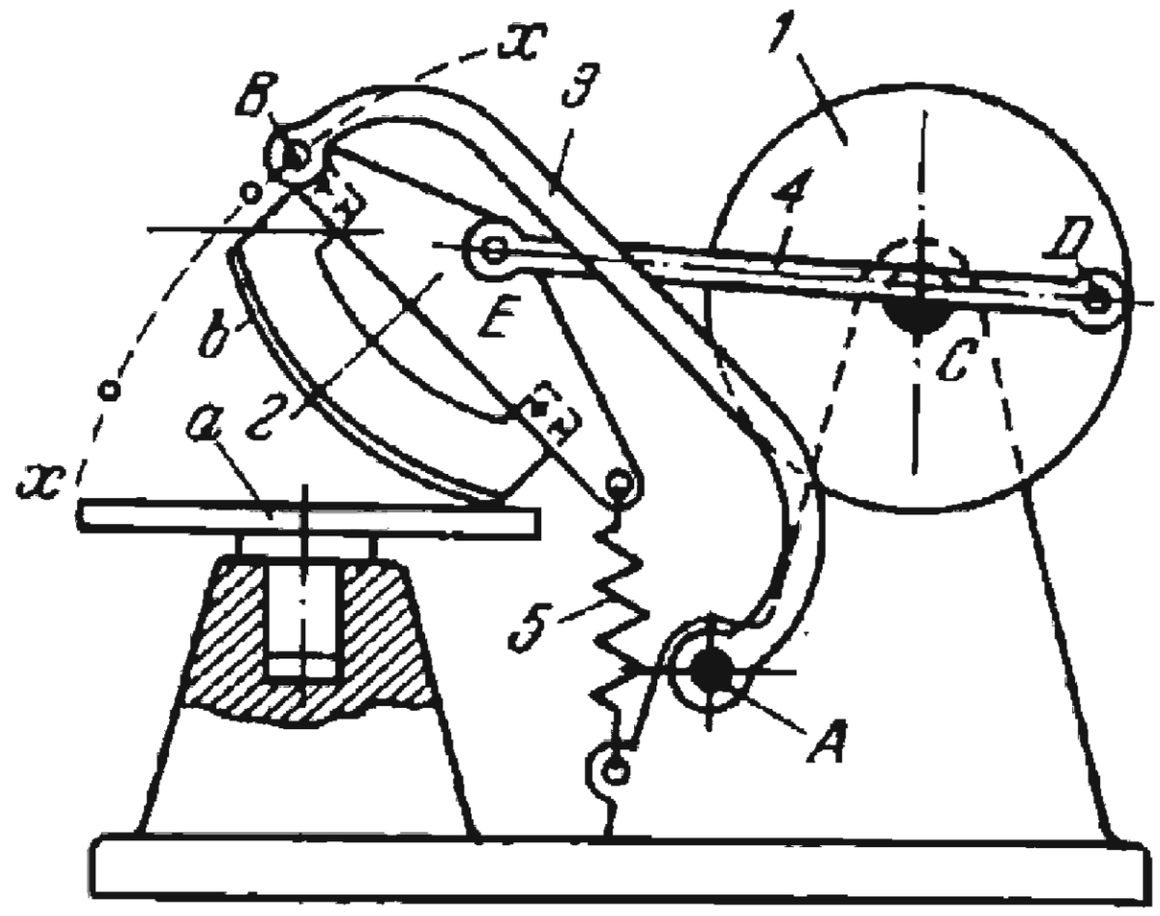
Slider *1* reciprocates. At the initial instant of motion of slider *1* in the direction of the arrow, pin *a* of the slider, in slot *d* of lever *2*, turns lever *2* clockwise together with lever *3* about fixed axis *A*. At this, the left end of lever *3*, designed as a cam, actuates roll *e* of index pin *4*, withdrawing the pin from its seat in the table (not shown). Before roll *e* runs off surface *b* of the cam, the table is swivelled by slider *1* through the required angle. Upon further motion of slider *1*, slot *d* of lever *2* becomes parallel to the line of motion of slider *1* and index pin *4* remains in the withdrawn position. In the reverse stroke of slider *1*, lever *2* is turned counterclockwise and lever *3*, overcoming the resistance of spring *5*, turns about axis *B* so that roll *e* moves along surface *f* of the cam, inserting index pin *4* into the next seat of the table. As soon as the end of lever *3* passes over roll *e*, the lever is returned by spring *5* to the position shown.

1730	LEVER-CAM MECHANISM FOR FEEDING PAPER TO A STACKER	LC FD



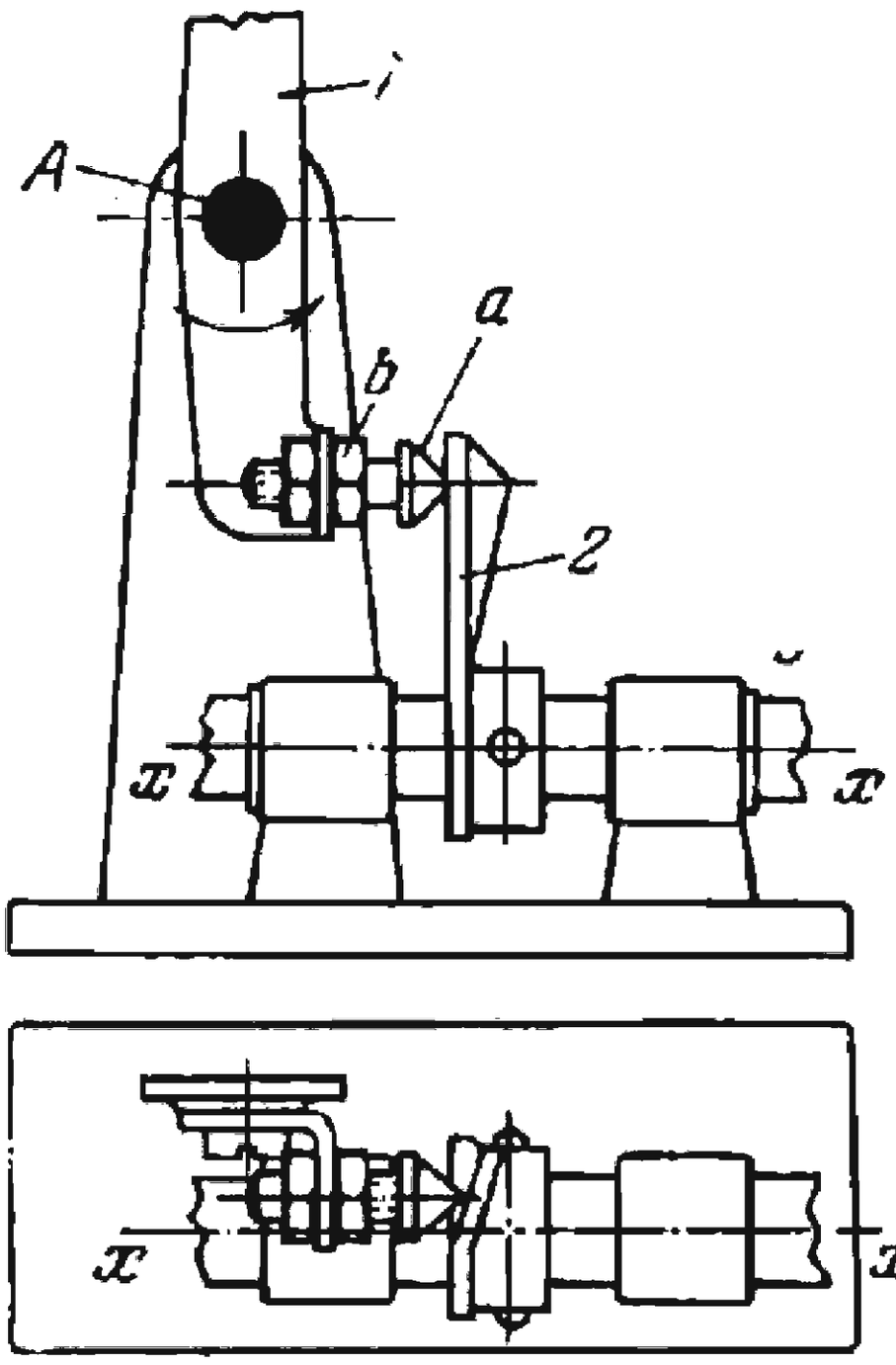
Crank *1* rotates about fixed axis *A*. Rocker arm *3* of four-bar linkage *ABCD* oscillates about fixed axis *D* and carries pawl *a* connected to it by turning pair *E*. Cam *10*, rigidly attached to crank *1*, oscillates rocker arm *7* of four-bar linkage *FGKH*. Link *5* turns about fixed axis *L* and has pin *b* which slides along slot *d* of lever *6*, thereby turning this lever about fixed axis *M*. The feeding of the paper is regulated by ratchet wheel *4* which is driven by crank *1*, mounted on the main shaft of the stacker, through connecting rod *2* and rocker arm *3* with pawl *a*. If the stack of paper is too low, link *5* with the feeler turns and deviates lever *6* so that lever *7* turns downward and pawl *a* of link *3* engages ratchet wheel *4* which actuates the mechanism for elevating the platform with the stack of paper (the platform elevating mechanism is not shown). Link *7* is raised, engaging paper feed, by links *8* and *9* which are actuated by cam *10* mounted on the main shaft of the stacker. Link *6* is returned to its initial position by spring *11*.

1731	LEVER-CAM ROLLING-LEVER MECHANISM OF A CUTTING MACHINE	LC FD



Crank *1* rotates about fixed axis *C* and is connected by turning pair *D* to link *4*. Link *3* turns about fixed axis *A*. Link *2* is connected by turning pairs *B* and *E* to links *3* and *4*, and carries rigidly attached knife *b*. When crank *1* rotates, knife *b* rolls along table *a*. The shape of knife *b* is chosen so that point *B* of link *2* describes circular arc *x*·*x* with its centre at point *A*. The distance $\overline{AB}$ on link *3* equals the radius of the arc described by point *B*. Spring *5* holds knife *b* against table *a*.

1732	LEVER-CAM DRIVE OF A MASTER CLOCK CONTACT BLADE	LC FD



Lever *1* turns about fixed axis *A*. Rigidly attached to lever *1* is a component with cone tip *a*. Plate *2* turns about fixed axis *x-x*. When lever *1* turns about axis *A*, tip *a* actuates bent plate *2* causing it to turn, together with shaft *B* on which it is rigidly mounted, about axis *x-x*. The contact blade of the master clock (not shown) is also mounted on shaft *B*. The drive is adjusted by screw *b*.

SECTION SEVEN

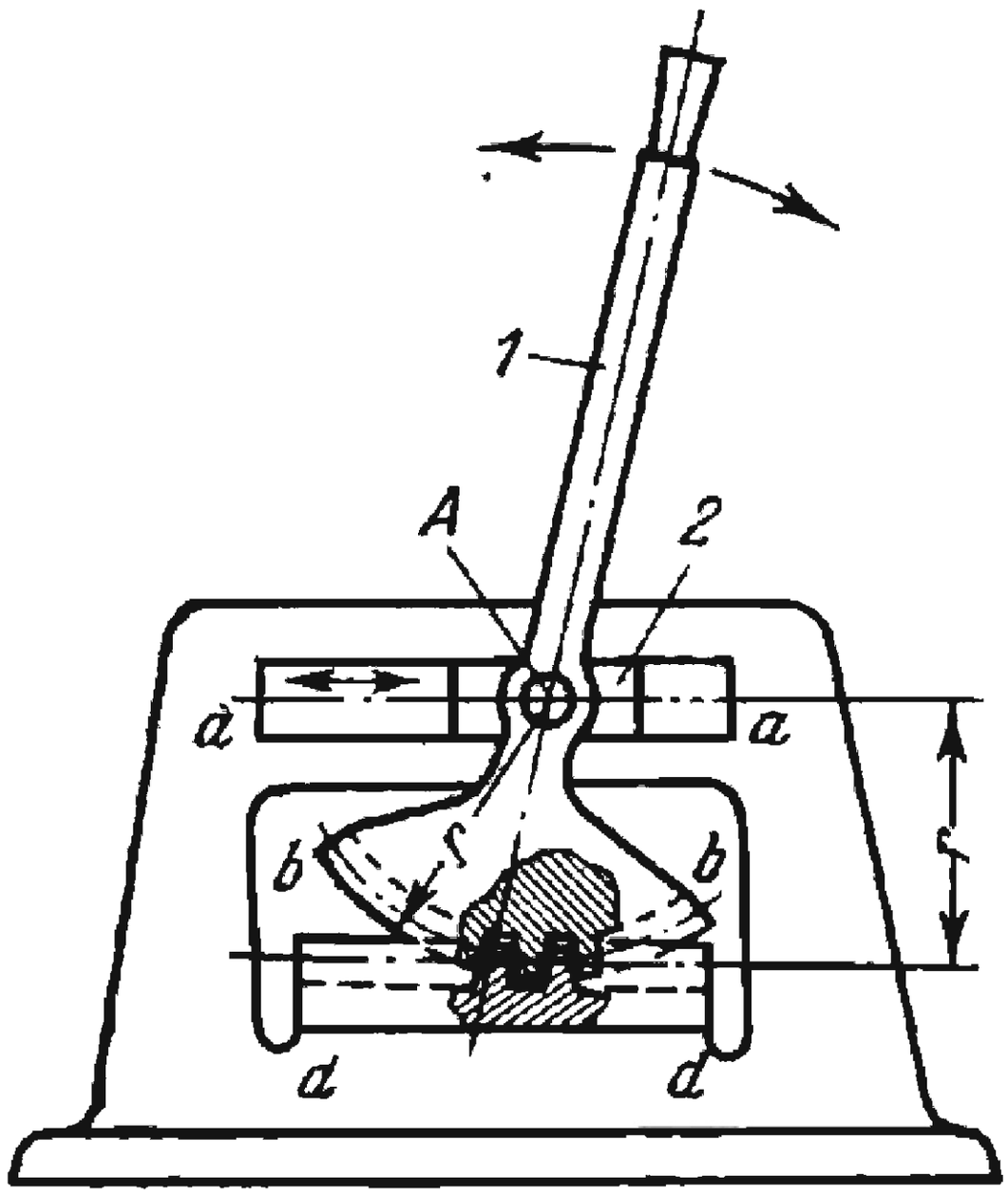
Gear-Lever Mechanisms

GL

1. General-Purpose Three-Link Mechanisms 3L (1733)
2. General-Purpose Four-Link Mechanisms 4L (1734 through 1738)
3. General-Purpose Five-Link Mechanisms 5L (1739 through 1744)
4. General-Purpose Six-Link Mechanisms 6L (1745)
5. General-Purpose Multiple-Link Mechanisms ML (1746 through 1749)
6. Dwell Mechanisms D (1750 through 1760)
7. Governor Mechanisms G (1761)
8. Mechanisms for Mathematical Operations MO (1762 and 1763)
9. Operating Claw Mechanisms of Motion Picture Cameras OC (1764)
10. Piston Machine Mechanisms PM (1765)
11. Hammer, Press and Die Mechanisms HP (1766, 1767 and 1768)
12. Mechanisms for Generating Curves Ge (1769 through 1773)
13. Switching, Engaging and Disengaging Mechanisms SE (1774)
14. Mechanisms of Measuring and Testing Devices M (1775 through 1782)
15. Mechanisms of Other Functional Devices FD (1783 through 1788)

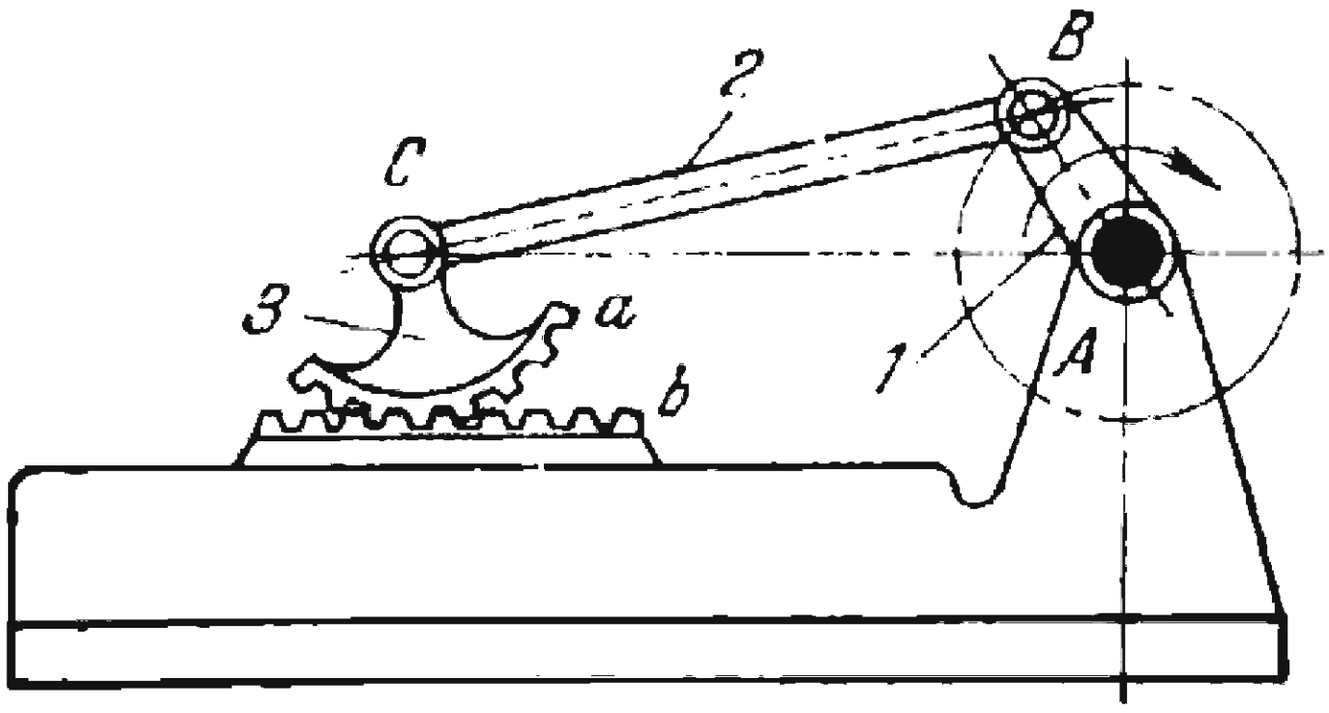
1. GENERAL-PURPOSE THREE-LINK MECHANISMS (1733)

1733	RACK-TYPE GEAR-LEVER MECHANISM	GL 3L



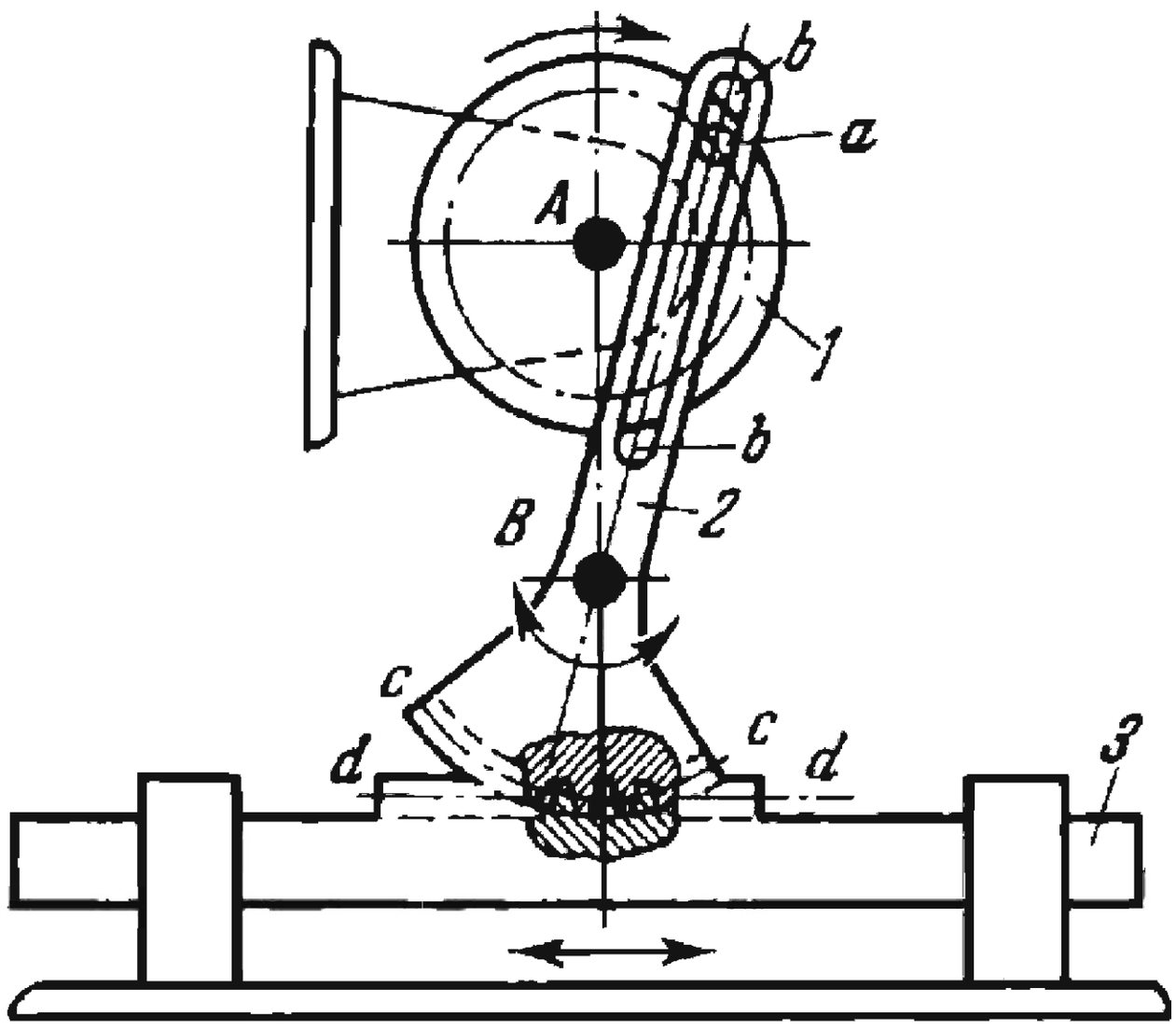
Lever *1* is connected by turning pair *A* to slider *2* which moves along fixed guides *a-a*. At its lower end lever *1* has gear segment *b-b* which meshes with and rolls along gear rack *d-d*, transmitting reciprocating motion to slider *2* along guides *a-a*.

1734	RACK-TYPE GEAR-LEVER MECHANISM	GL 4L

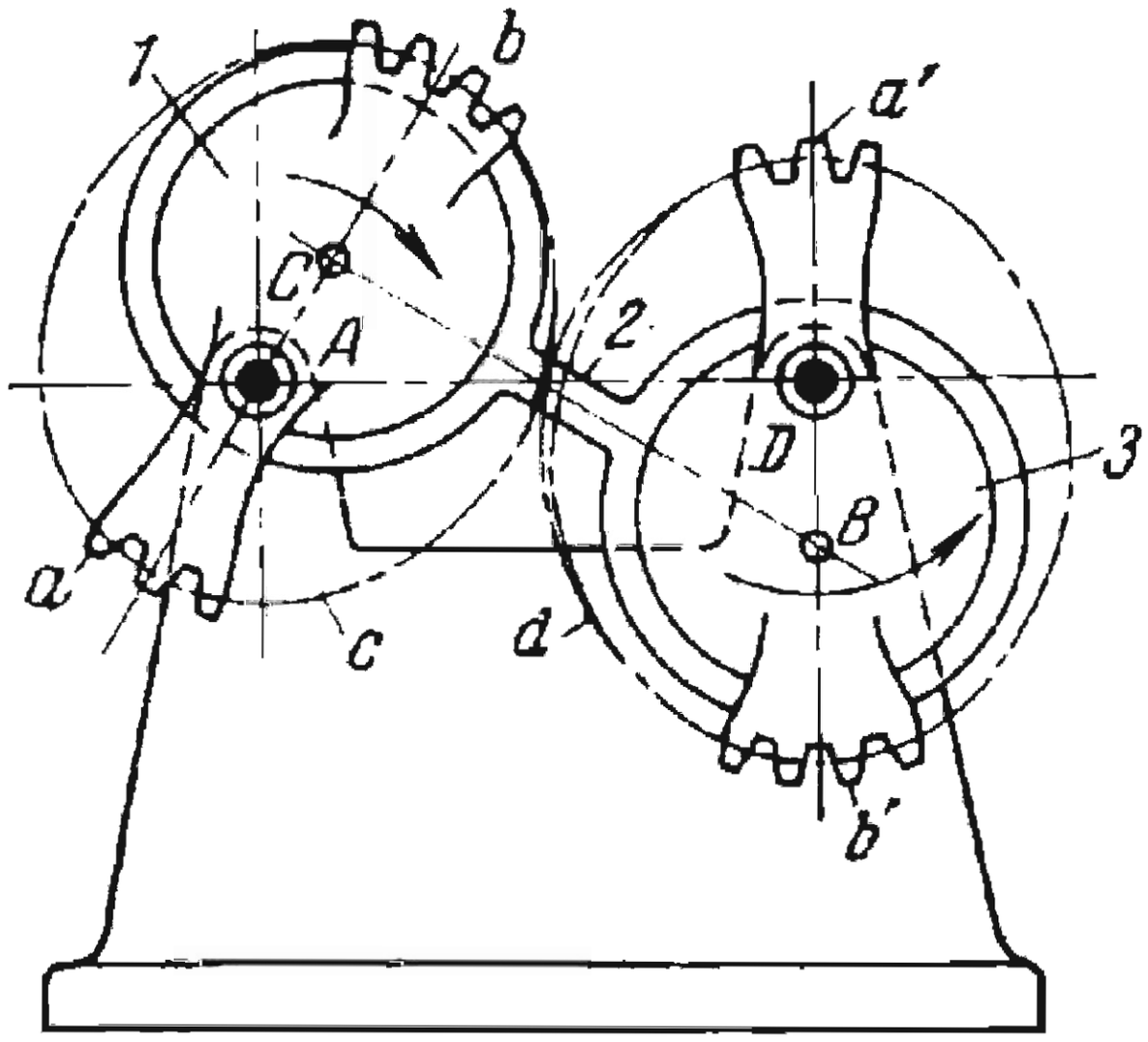


Connecting rod *2* is connected by turning pair *B* to crank *1*, rotating about fixed axis *A*, and by turning pair *C*, to link *3*. Link *3* has circular gear segment *a* of a round gear which meshes with and rolls along fixed gear rack *b*. Point *C* has straight-line reciprocating motion.

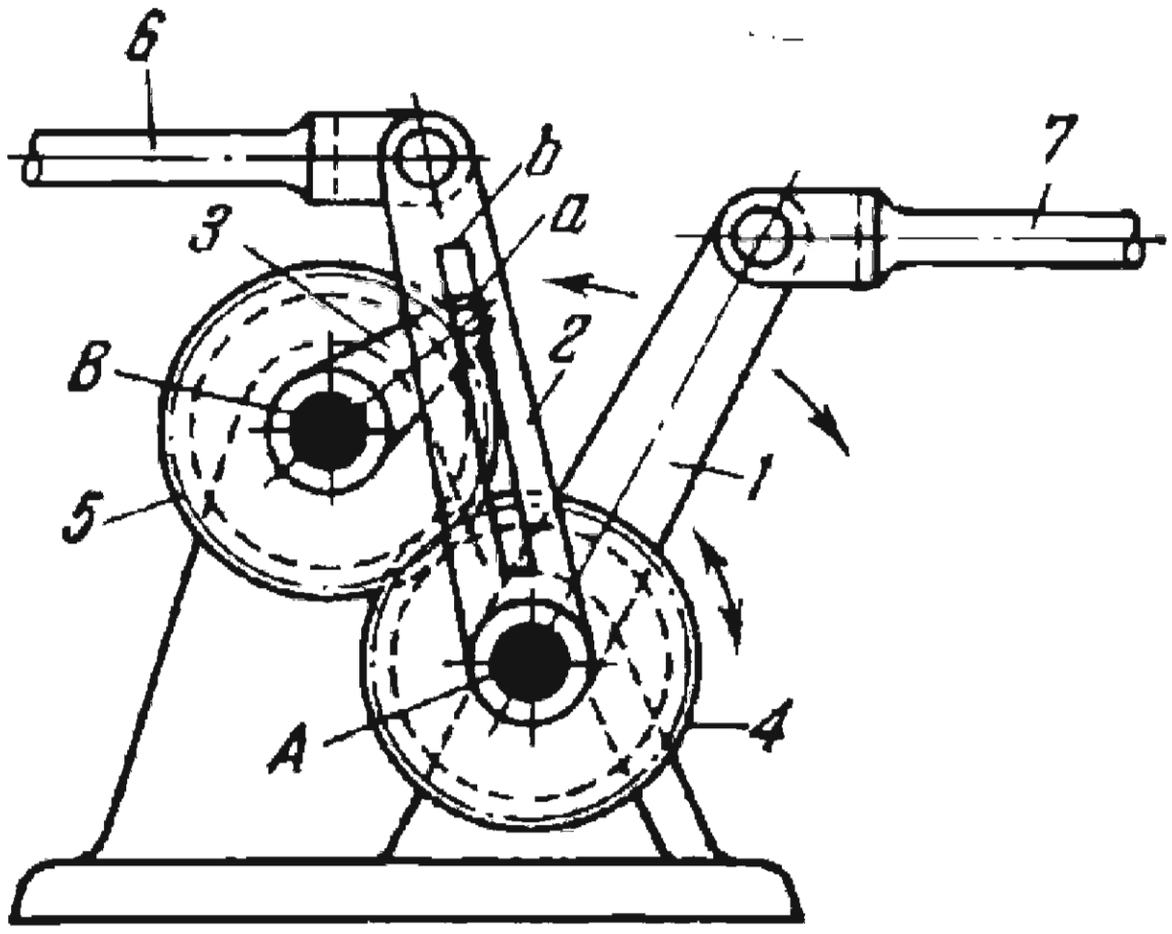
1735	FOUR-BAR SLOTTED LINK MECHANISM WITH RACK AND SEGMENT GEAR	GL 4L



Disk *1* rotates about fixed axis *A* and has pin *a* sliding along slot *b-b* of link *2* which turns about fixed axis *B*. Link *2* has gear segment *c-c* which meshes with gear rack *d-d* of slider *3*. The times required for the forward and return strokes of slider *3* differ.

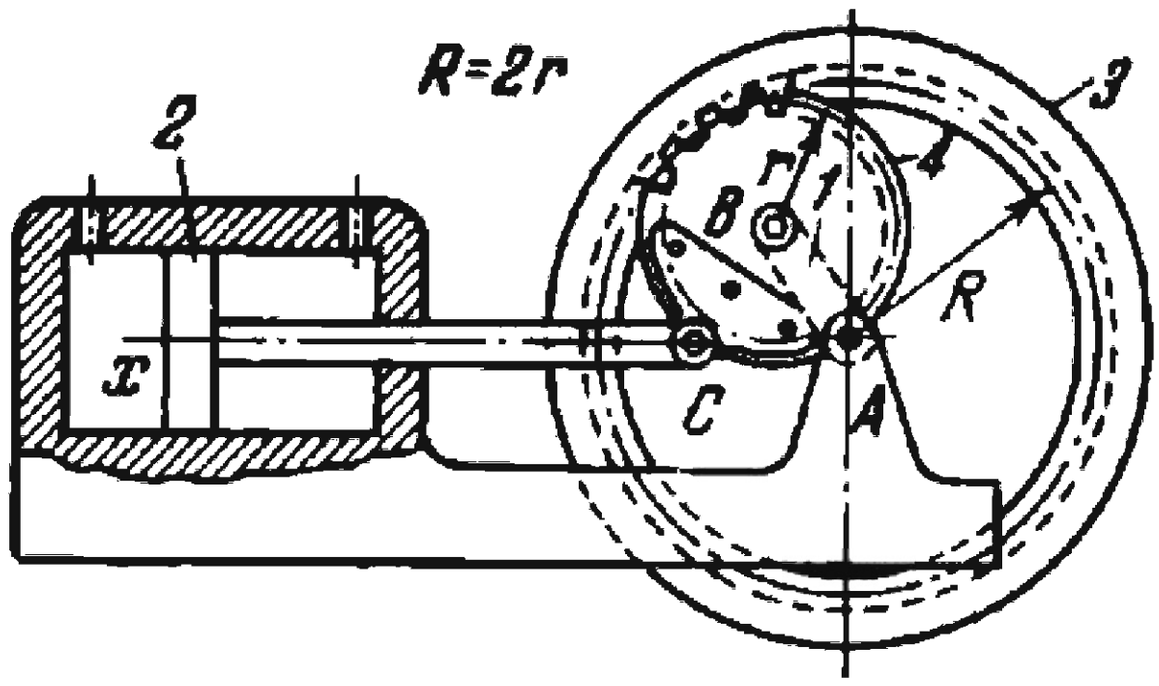


The lengths of the links comply with the conditions: $\overline{AC} = \overline{DB}$ and $\overline{AD} = \overline{CB}$. Cranks *1* and *3* are designed as round eccentrics rotating about fixed axes *A* and *D*. Connecting rod *2* has collars encircling these eccentrics. When eccentric *1* rotates clockwise, eccentric *3* rotates counterclockwise. At the right-hand extreme (dead-centre) position of the mechanism, gear segment *b* of eccentric *1* meshes with gear segment *a'* of eccentric *3*. At the left-hand extreme (dead-centre) position, gear segments *a* and *b'* mesh. As a result uncertainty of motion of the mechanism is eliminated. The mechanism is equivalent to two meshing elliptical gears *c* and *d* with the foci of the ellipses at points *A*, *C*, *B* and *D*.



Lever *1* is oscillated about fixed axis *A* by intermediate link *7* from a drive which is not shown. Lever *1* is rigidly attached to gear *4* which meshes with gear *5*, turning about fixed axis *B*. Rigidly attached to gear *5* is crank *3* whose pin *a* slides along slot *b* of lever *2* which turns freely about axis *A*. Lever *2* transmits reciprocating motion to intermediate link *6* which is connected to the driven part of the mechanism (not shown). Thus the oscillation of lever *1* is converted into double oscillation of lever *2*.

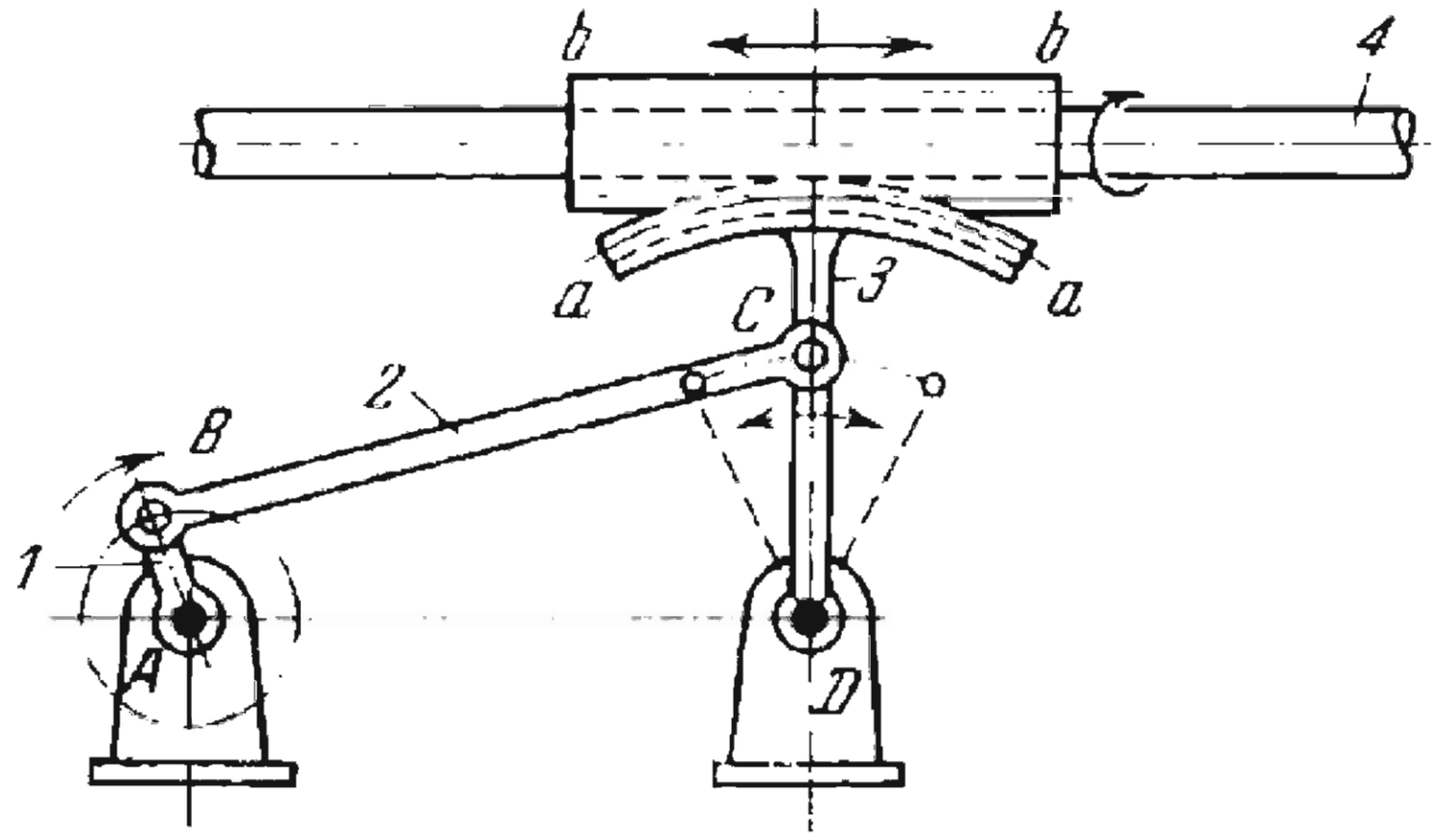
1738	GEAR-LEVER CARDAN-CIRCLE PLANETARY MECHANISM	GL 4L



Crank *1* rotates about fixed axis *A*. Gear *4* is connected by turning pair *B* to crank *1* and meshes with fixed internal gear *3*. If the radii *R* and *r* of the pitch circles of the gears comply with the condition: $R/r = 2$, then point *C*, lying on the pitch circle moves along straight line *Ax*. Thus the mechanism converts reciprocation of piston *2* along its guides into rotation of crank *1* about axis *A*.

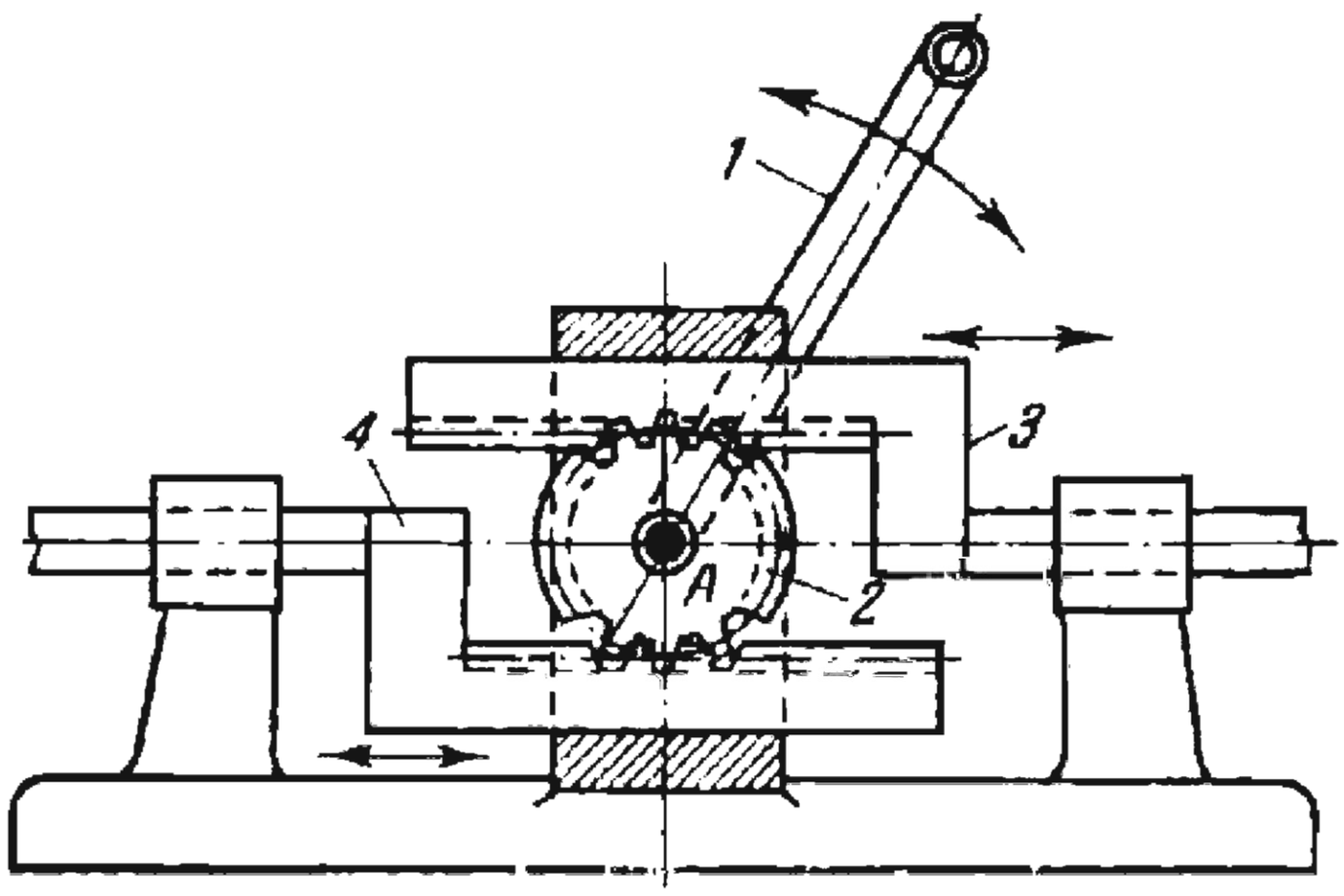
3. GENERAL-PURPOSE FIVE-LINK MECHANISMS
(1739 through 1744)

1739	GEAR-LEVER MECHANISM WITH WORM GEARING	GL 5L

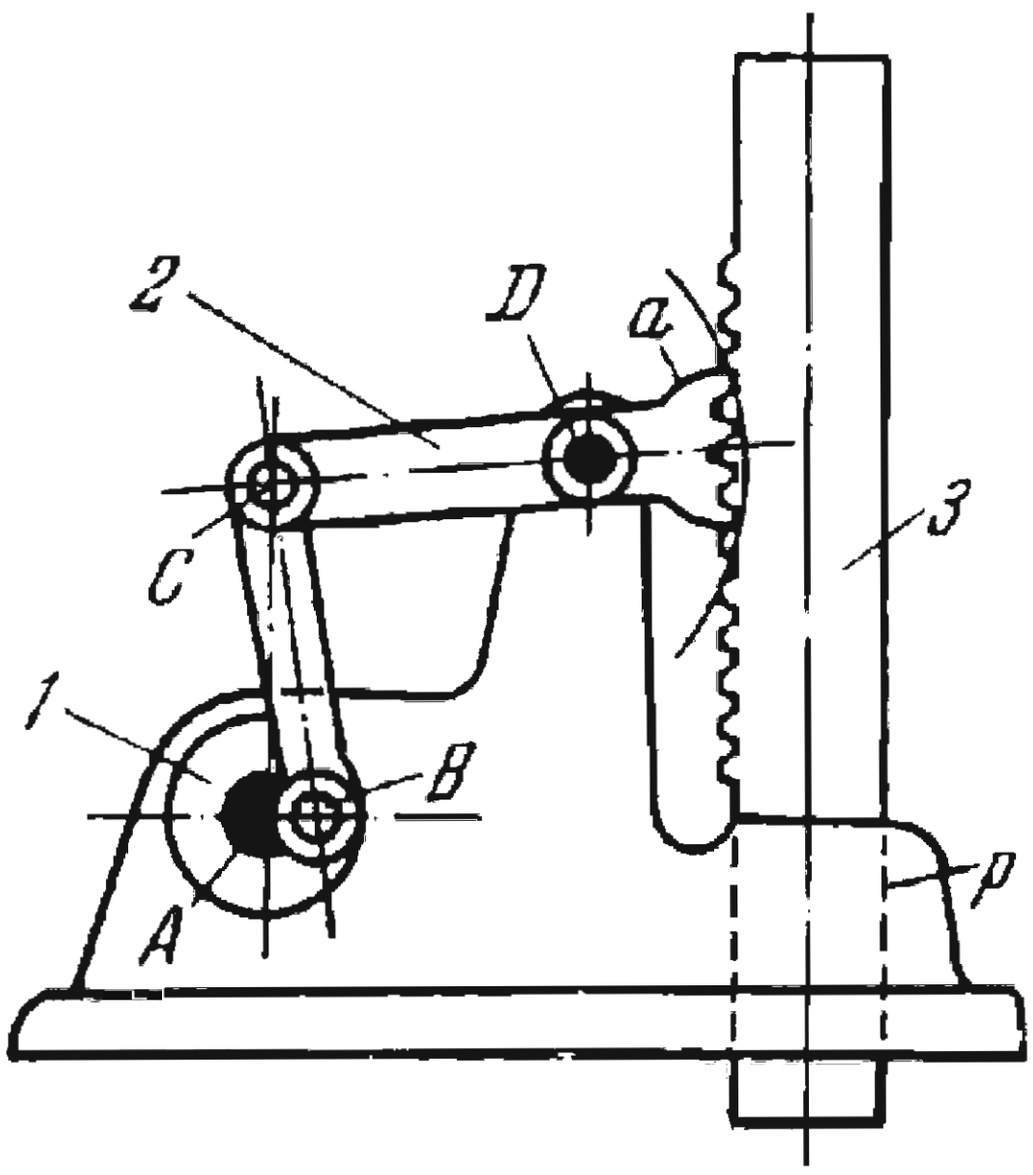


Segment *a-a* of helical gear *3* is the rocker arm of four-bar linkage *ABCD*. When crank *1* rotates about fixed axis *A*, link *3* either rotates or reciprocates link *4* on which worm *b-b* is mounted. Rotation of link *4* is obtained by proper selection of the pitch and helix angle of the worm.

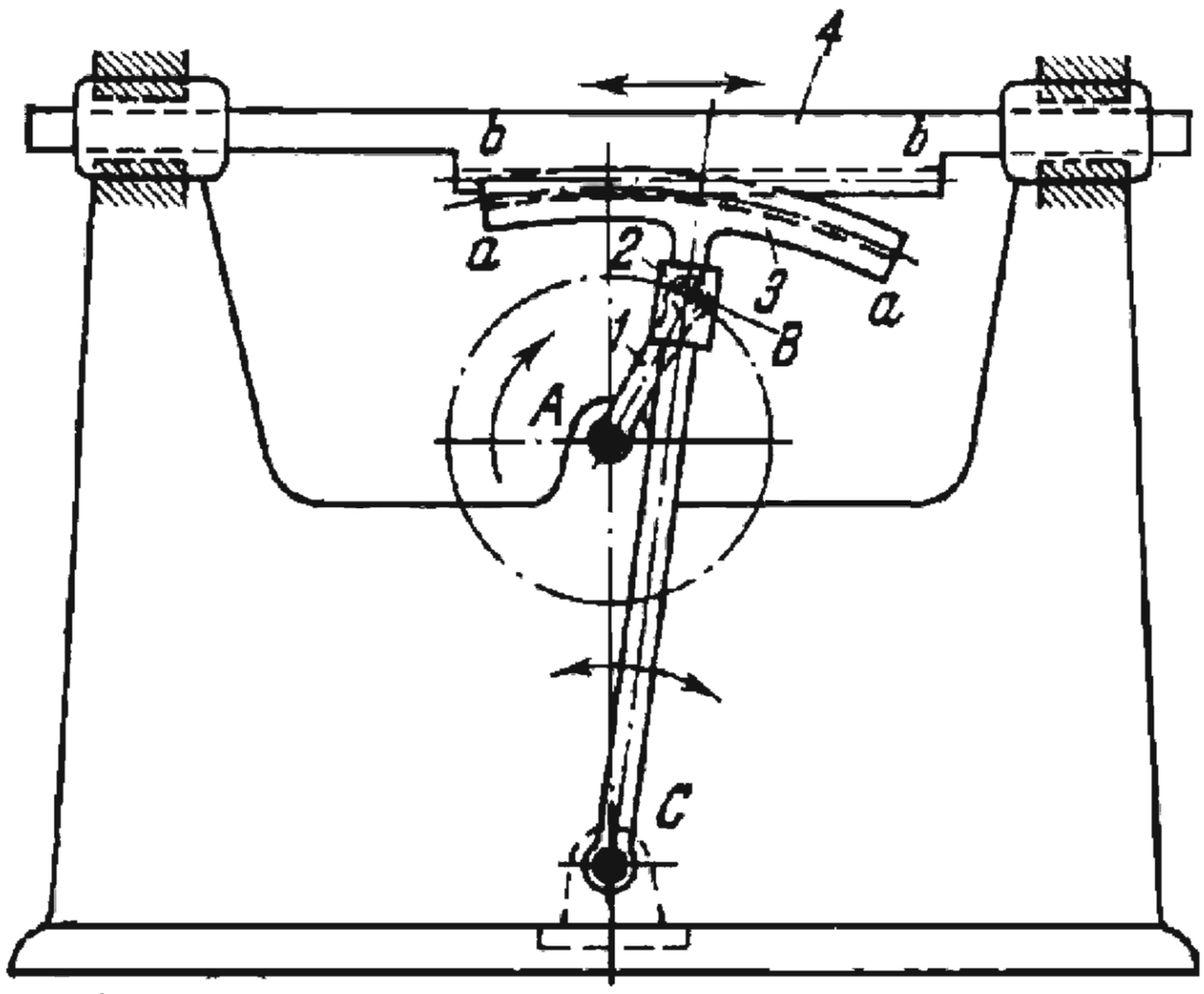
1740	DOUBLE-RACK GEAR-LEVER MECHANISM	GL 5L



Rigidly attached to lever *1*, turning about fixed axis *A*. is gear *2* which meshes with two gear racks, *3* and *4*. When lever *1* is oscillated, racks *3* and *4* reciprocate in opposite directions at equal velocities.



Rocker arm *2* of four-bar linkage *ABCD* turns about fixed axis *D* and has circular gear segment *a* which meshes with gear rack *3*. Rack *3* slides in fixed guide *p*. When crank *1* rotates about fixed axis *A*, rocker arm *2* transmits reciprocating motion to rack *3*.

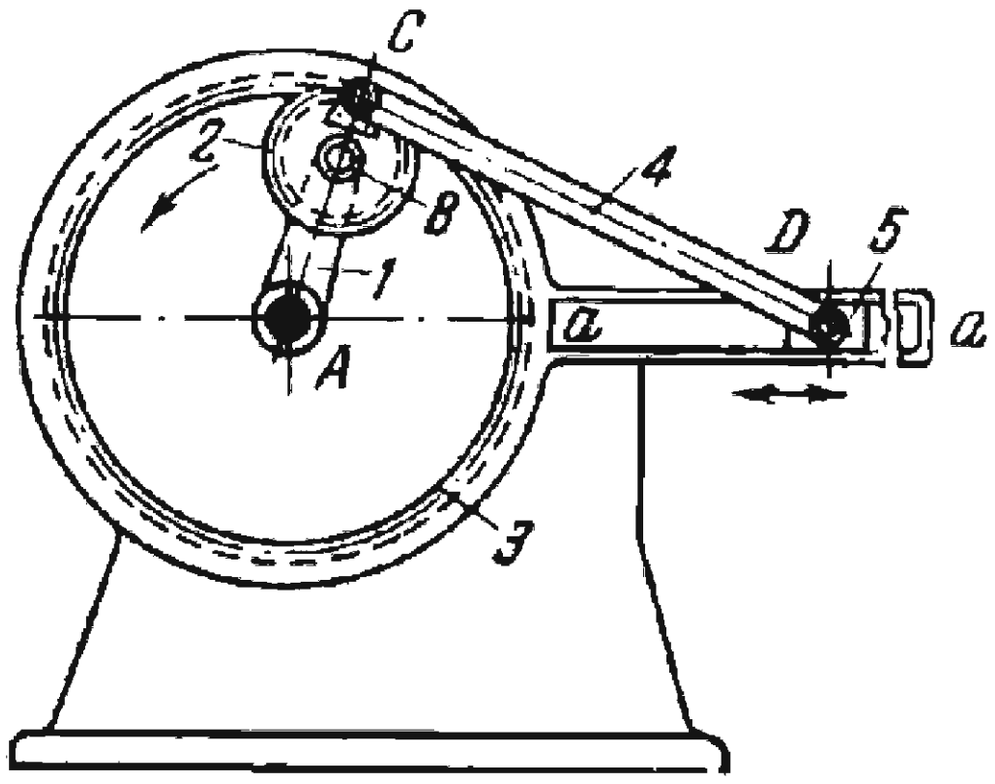


Link *3* carries gear segment *a-a* whose centre coincides with point *C*. Segment *a-a* meshes with gear rack *b-b* of link *4*. When crank *1* rotates at uniform velocity about fixed axis *A*, the time ratio of the forward to the return stroke of link *4* is

$$k = \frac{\pi - \arccos \dfrac{\overline{AB}}{\overline{AC}}}{\arccos \dfrac{\overline{AB}}{\overline{AC}}} .$$

1743 GEAR-LEVER INTERNAL-GEARING PLANETARY MECHANISM

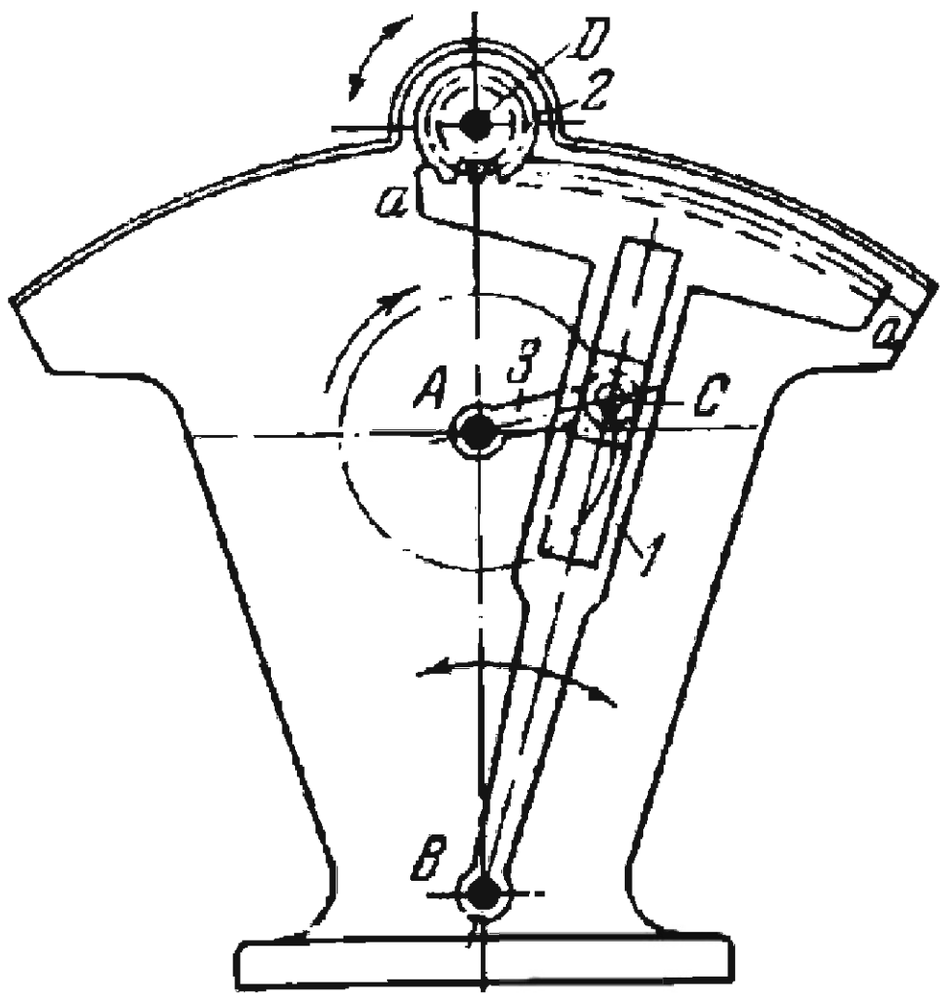
GL 5L



Gear *2*, meshing with fixed internal gear *3*, is driven by crank *1* which rotates about fixed axis *A*. Point *C* of gear *2* describes a hypocycloid whose shape depends on the ratio of the radii of gears *2* and *3*. Connecting rod *4* is connected by turning pairs *C* and *D* to gear *2* and to slider *5* which moves along fixed guides *a-a*. When crank *1* rotates about axis *A*, gear *2* rolls around in gear *3*, reciprocating slider *5* through connecting rod *4*.

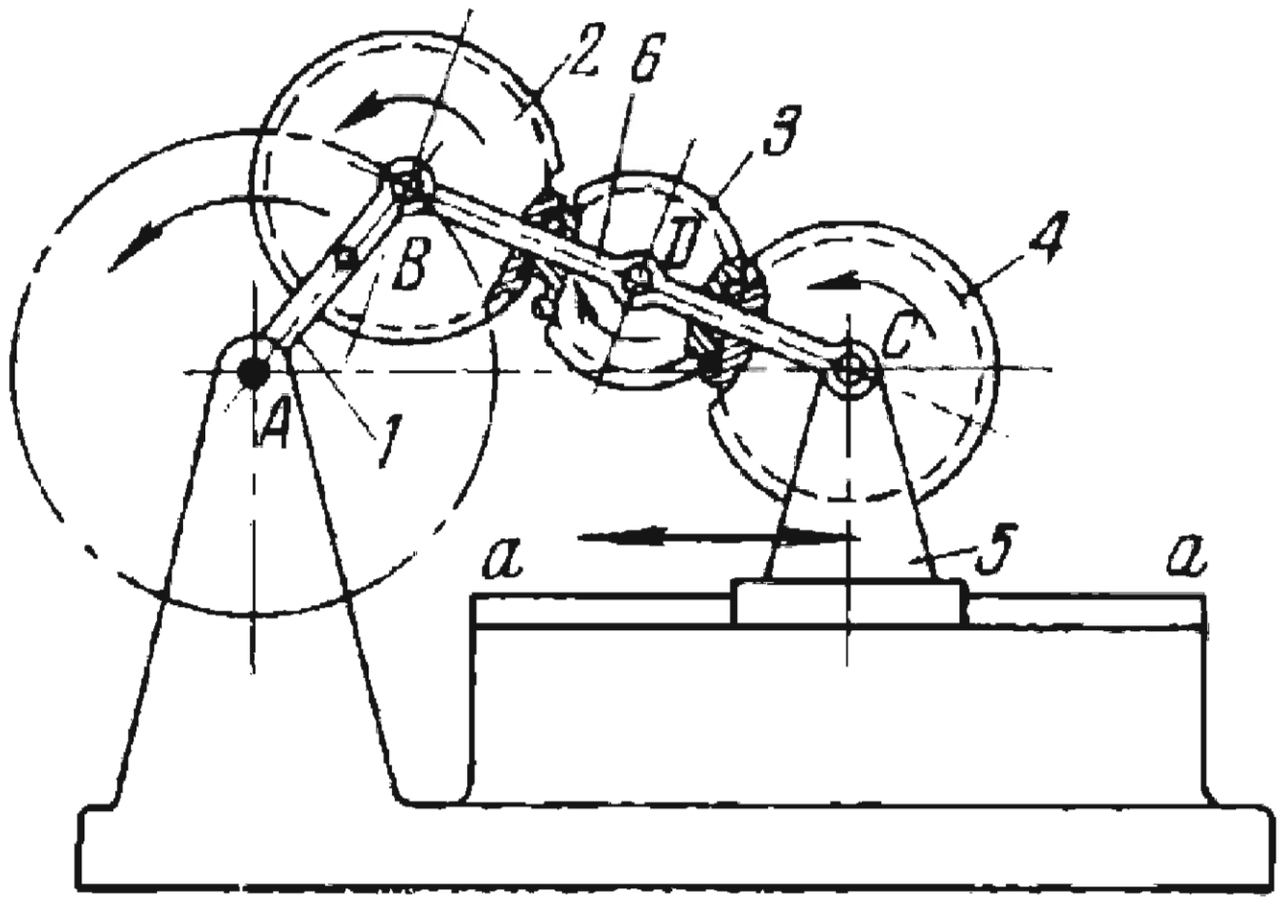
1744 GEAR-LEVER MECHANISM WITH PINION AND SEGMENT GEAR

GL 5L



Slotted link *1* carries gear segment *a-a* which meshes with pinion *2*, rotating about fixed axis *D*. When crank *3* rotates about fixed axis *A*, link *1* oscillates about fixed axis *B* and pinion *2* rotates first in one direction and then in the other, the times of rotation in each direction being different.

1745	GEAR-LEVER PLANETARY MECHANISM WITH EXTERNAL GEARING	GL 6L



Gear *2* has its centre at point *B* and is rigidly attached to crank *1* which rotates about fixed axis *A*. Gear *2* meshes with gear *3* which rotates about axis *D* of connecting rod *6*. Gear *3*, in turn, meshes with gear *4* which rotates about axis *C* of slider *5*. Slider *5* of slider-crank linkage *ABC* reciprocates along fixed guides *a-a*.

5. GENERAL-PURPOSE MULTIPLE-LINK MECHANISMS (1746 through 1749)

1746	DOUBLE-RACK GEAR-LEVER MECHANISM	GL ML

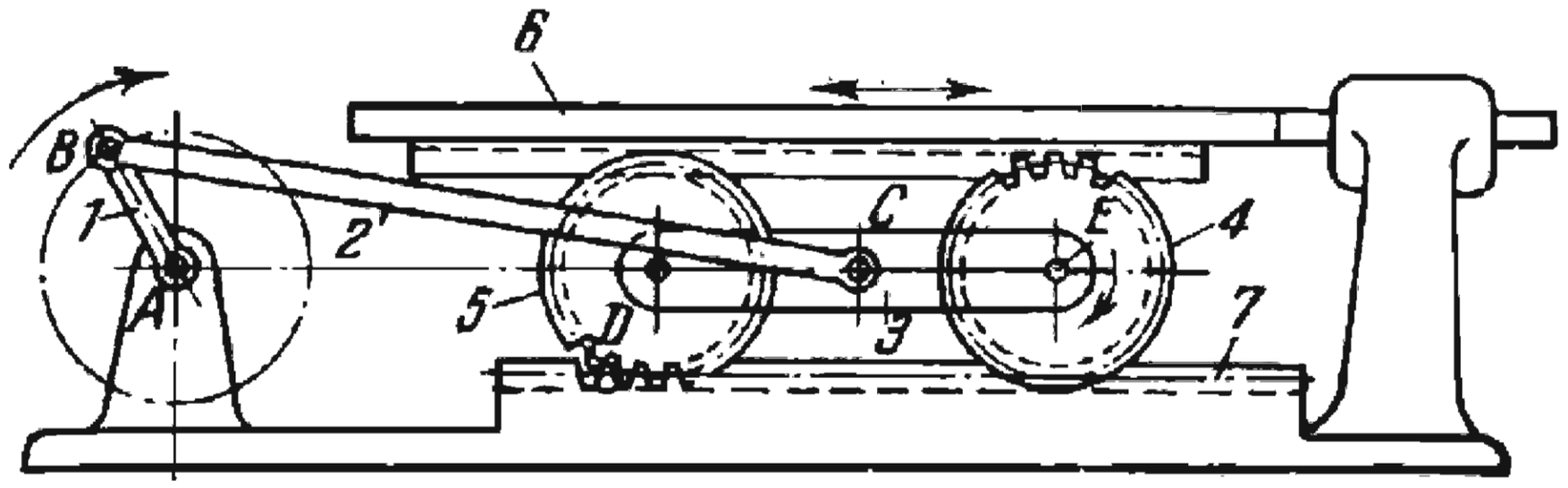
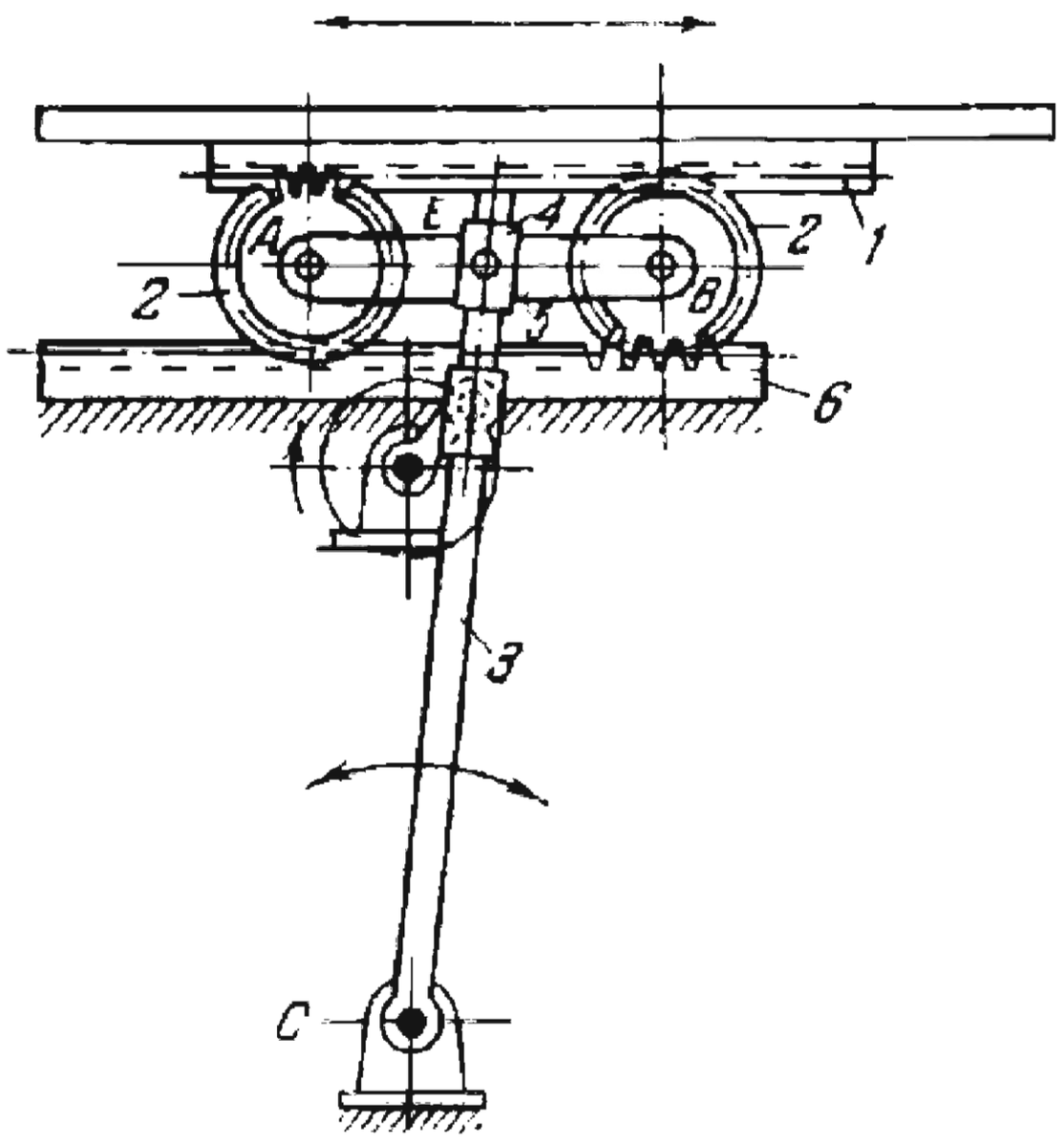


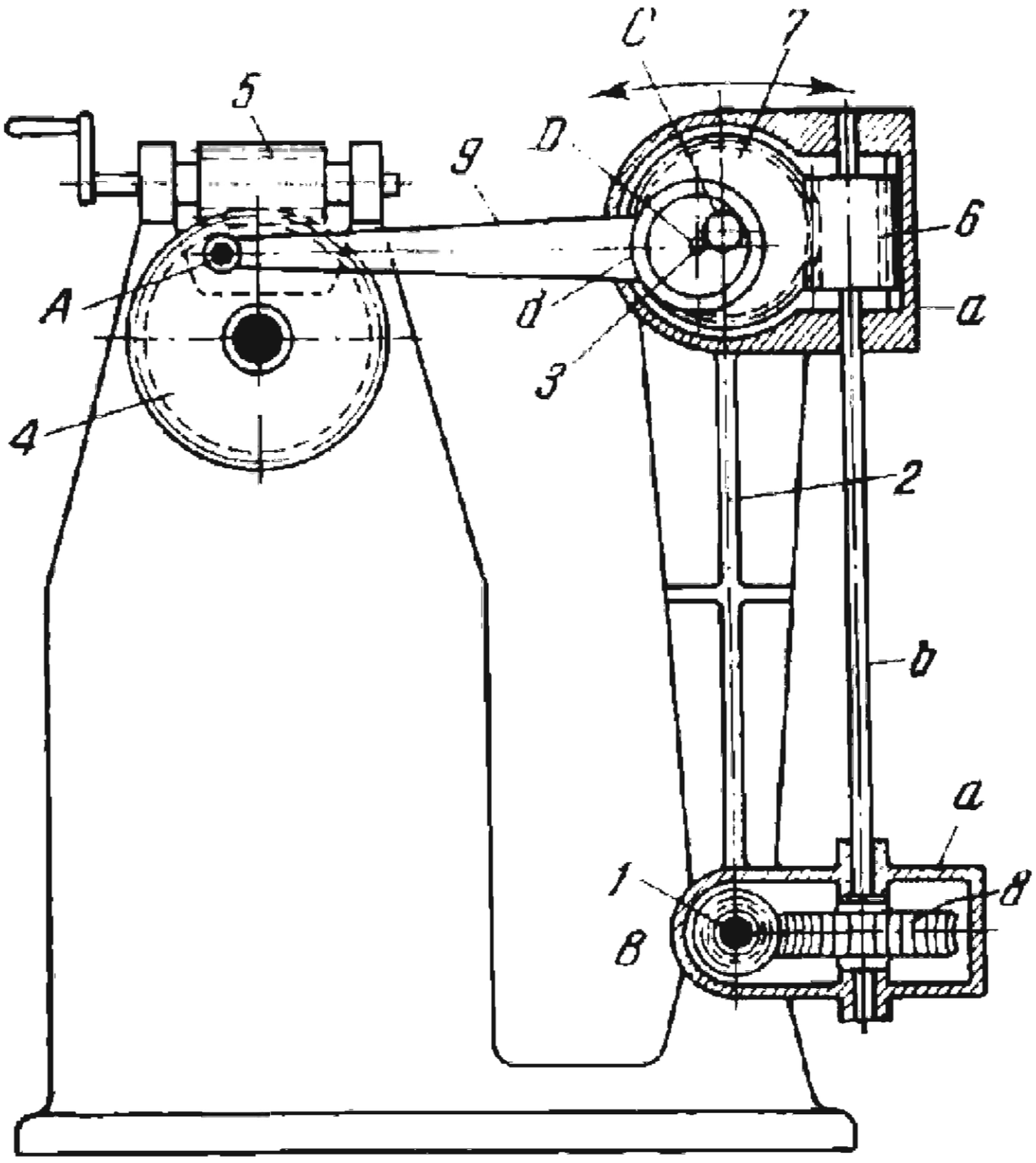
Plate *3* is connected by turning pair *C* to connecting rod *2* of slider-crank linkage *ABC*. Plate *3* is connected by turning pairs *D* and *E* to two gears, *5* and *4*, of equal diameter. Gears *4* and *5* mesh with sliding gear rack *6* and with fixed gear rack *7*. The length of the stroke of the upper rack is twice that of the centres of the gears. This relationship holds for any diameter of gears *4* and *5*.

1747	DOUBLE-RACK GEAR-LEVER MECHANISM	GL ML



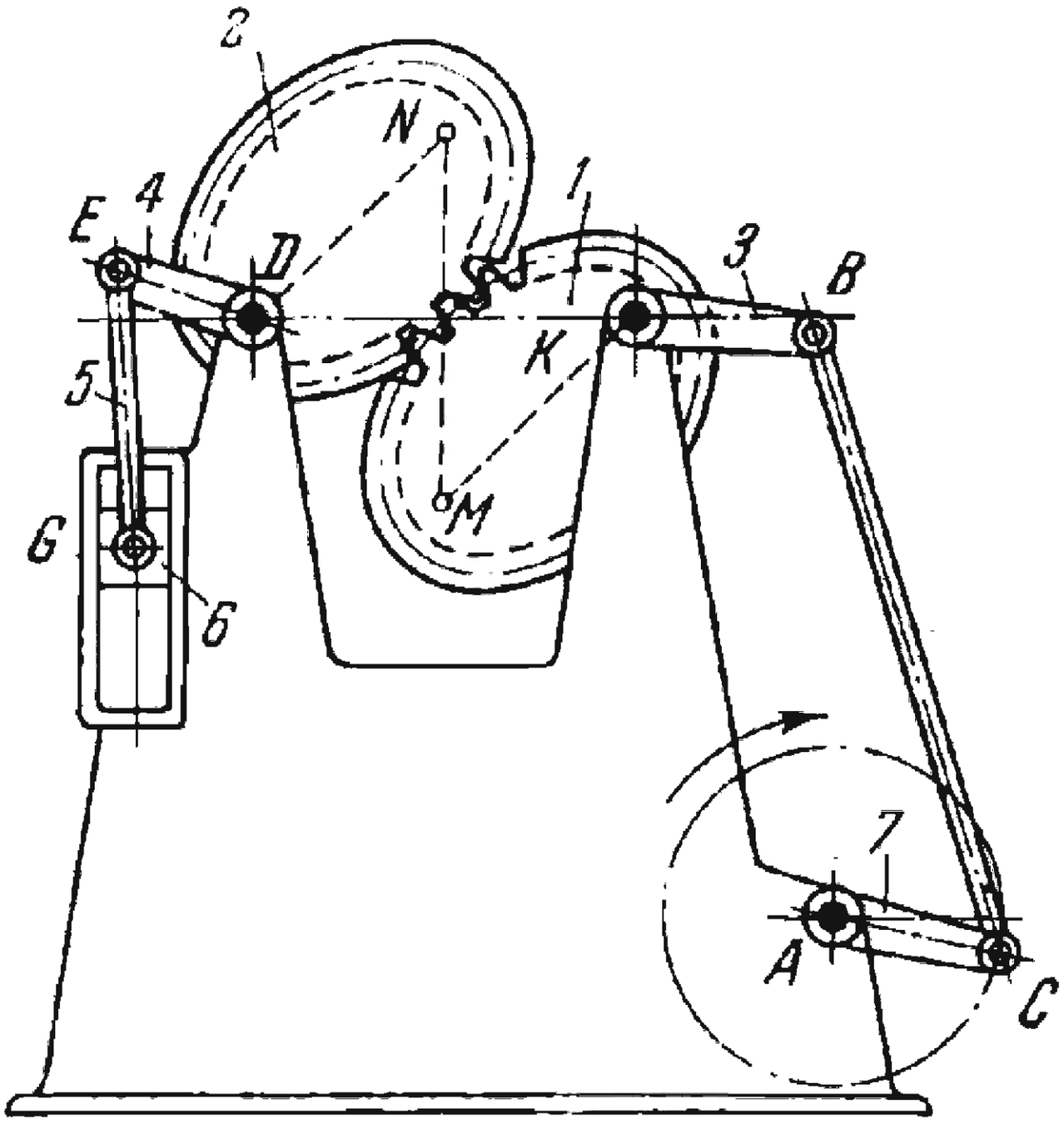
Link *3* turns about fixed axis *C* and slides in slider *4* which is connected by turning pair *E* to plate *5*. Plate *5* is connected by turning pairs *A* and *B* to two gears *2* of equal diameter which roll along fixed gear rack *6* and mesh with gear rack *1*. The length of the stroke of upper rack *6* is twice that of axes *A* and *B* of gears *2*.

1748	GEAR-LEVER MECHANISM WITH DRIVEN LINK ANGLE OF OSCILLATION ADJUSTMENT	GL ML



Link *2* turns about fixed axis *B* and has housings *a* which contain worm-gearing mechanisms consisting of worms *1* and *6* and worm wheels *8* and *7*. Worm *1* rotates about axis *B* and transmits rotation through worm wheel *8*, intermediate shaft *b* and worm *6* to worm wheel *7* and eccentric *3*. Eccentric *3* rotates together with worm wheel *7* about axis *C* and is encircled by collar *d* of link *9* which turns about fixed axis *A*. Thus the mechanism is the four-bar double-swing linkage *ADCB* of which the eccentric, belonging to the connecting rod, is the driving link. When worm *1* rotates about axis *B*, link *2* oscillates about this axis. The angle of oscillation of link *2* can be adjusted by changing the position of fixed axis *A*. This is done by turning worm *5* and thereby transmitting rotation to worm wheel *4* on which the axis of rotation of link *9* is rigidly attached.

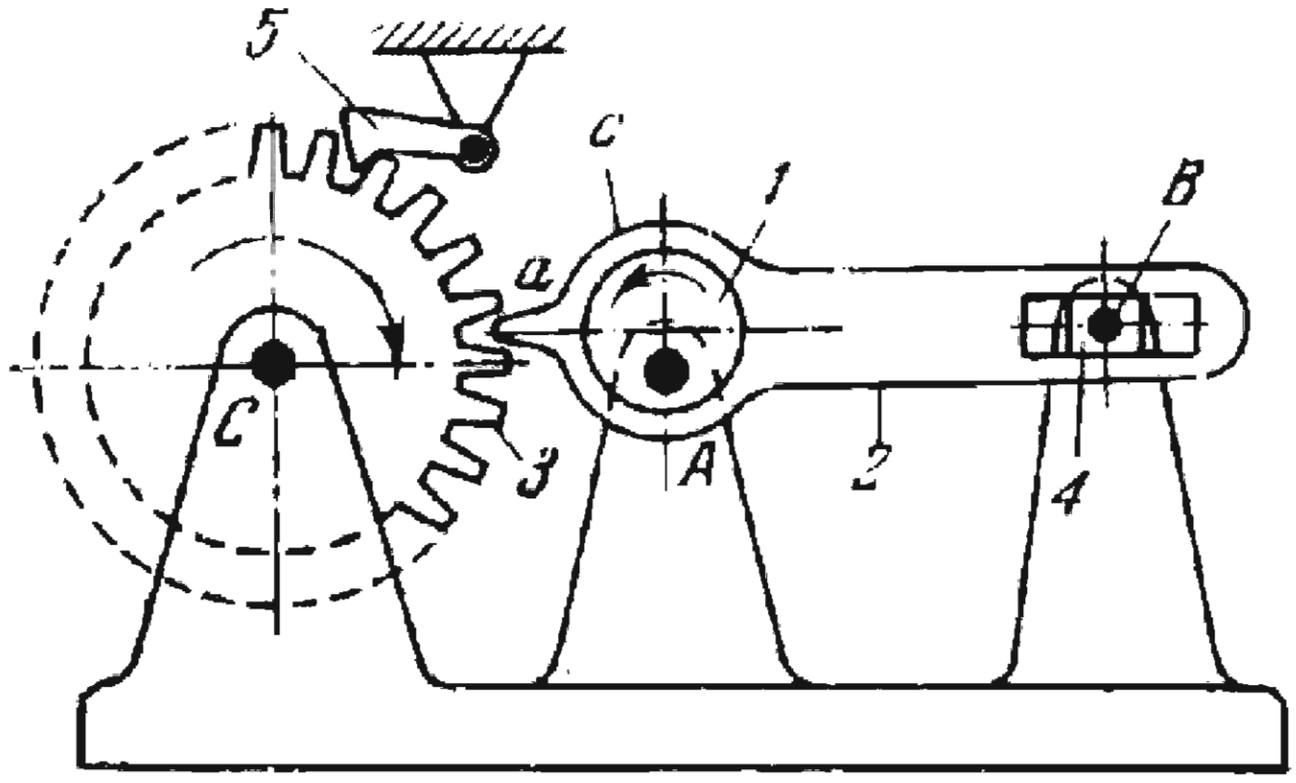
1749	GEAR-LEVER MECHANISM WITH ELLIPTICAL GEARS	GL ML



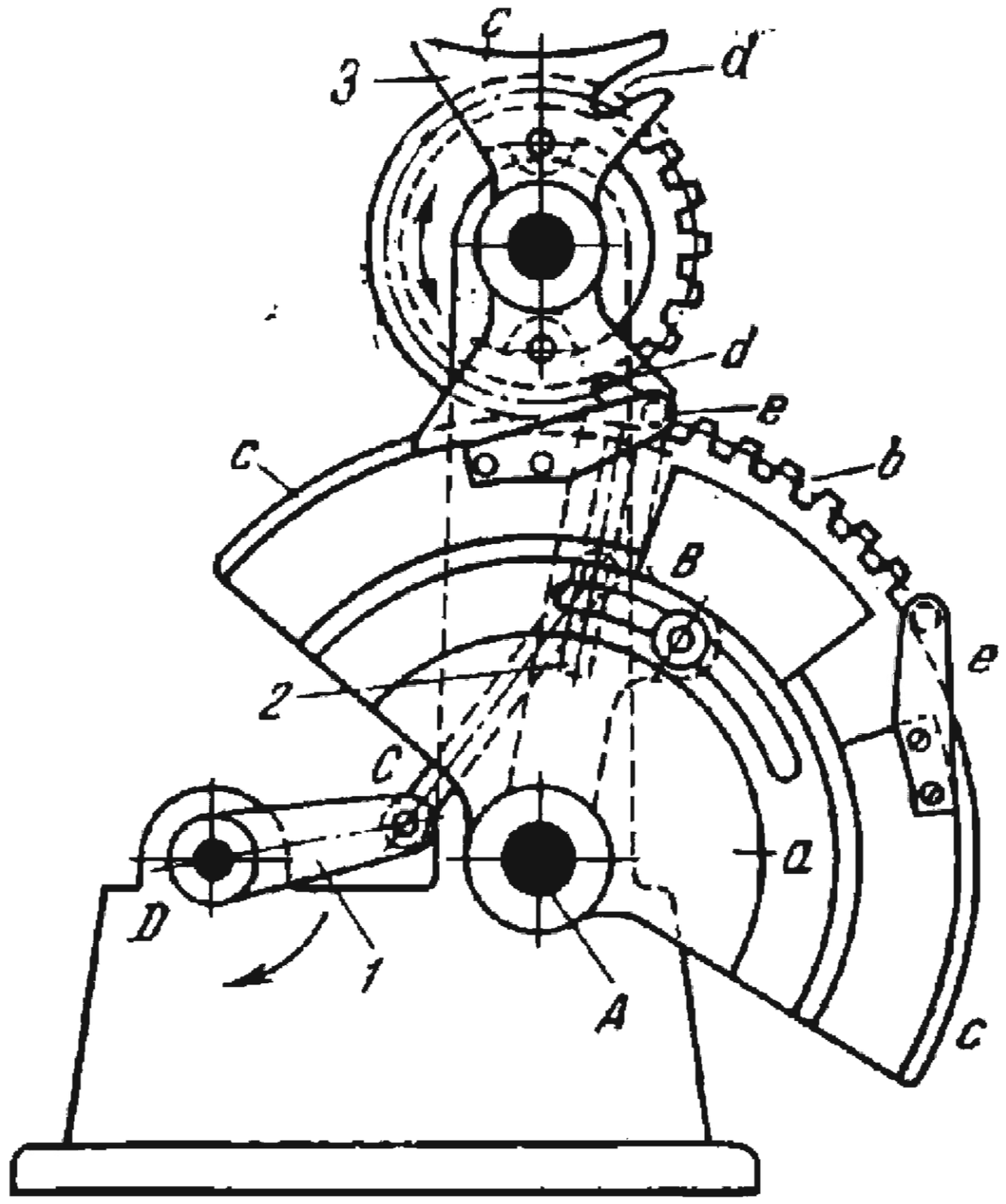
The lengths of the links comply with the conditions: $\overline{AC} = \overline{KB}$ and $\overline{BC} = \overline{KA}$. Elliptical gears *1* and *2* are of the same shape and size, and are rigidly attached to links *3* and *4*. Connecting rod *5* is connected by turning pairs *E* and *G* to link *4* and slider *6*. Slider *6* moves in a fixed guide. Centres *K* and *D* of rotation of the gears coincide with foci of the ellipses. Elliptical gears *1* and *2* can be replaced by crossed-crank linkage *DNMK* in which the lengths of the links comply with the conditions: $\overline{DN} = \overline{KM}$ and $\overline{NM} = \overline{DK}$, and where points *N* and *M* also coincide with foci of the ellipses. Links *3* and *7* rotate in the same direction at the same angular velocity.

6. DWELL MECHANISMS (1750 through 1760)

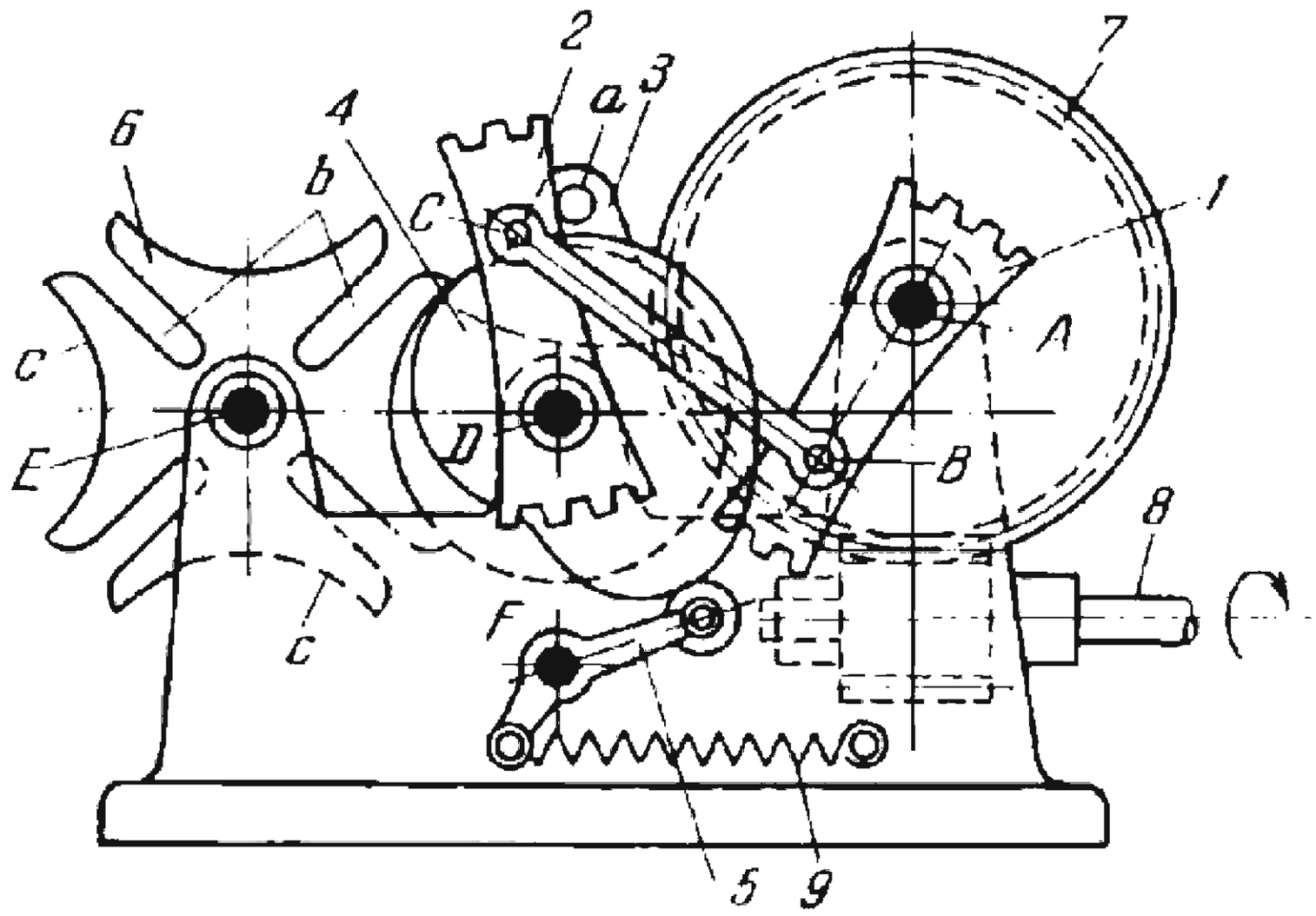
1750	GEAR-LEVER DWELL MECHANISM	GL D



Link *1*, designed as a round eccentric, rotates about fixed axis *A*. Link *2* has collar *c* encircling eccentric *1*. Link *2* is connected by a sliding pair to slider *4* which turns about fixed axis *B*. Gear *3* rotates about fixed axis *C*. When eccentric *1* rotates, tooth *a* of link *2* engages the teeth of gear *3* consecutively, turning the gear. Pawl *5* indexes the gear in each position. In one revolution of link *1*, gear *3* turns through an angle of $\alpha = 360°/z$, where z is the number of teeth of gear *3*.

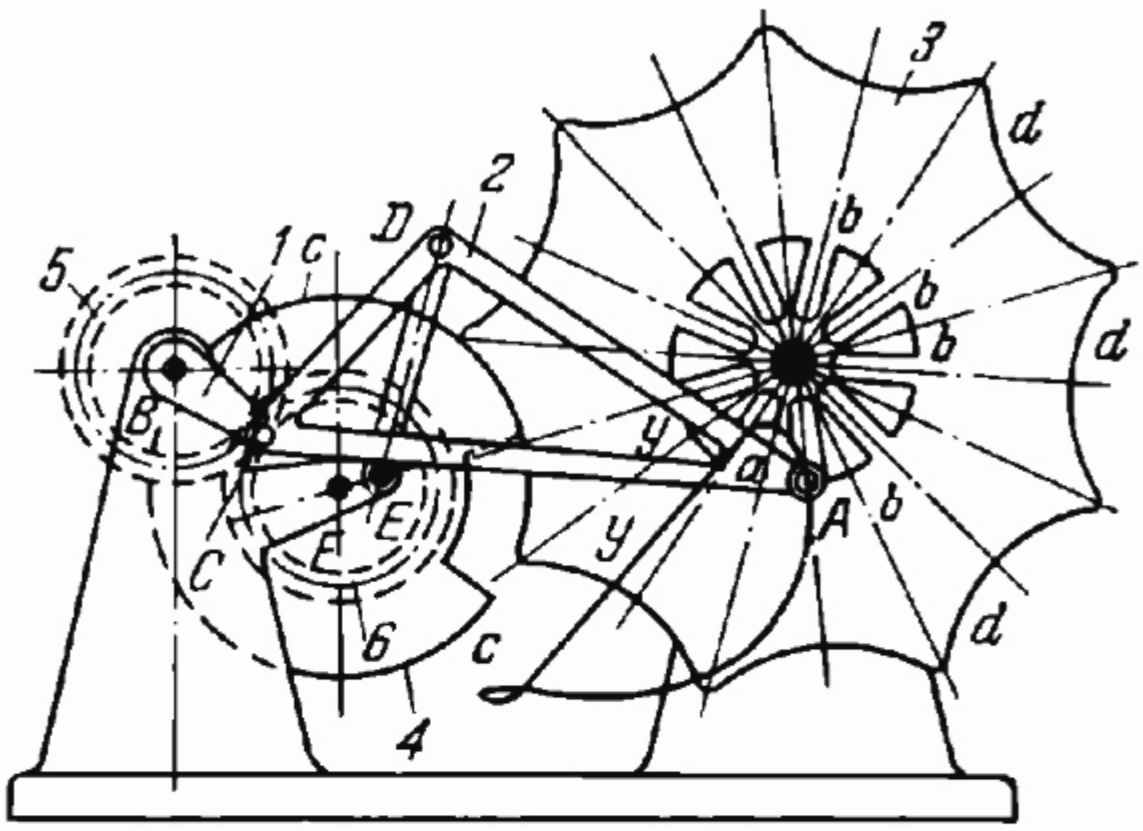


Crank *1* of four-bar linkage *DCBA* rotates about fixed axis *D*. Rocker arm *2*, turning about fixed axis *A*, is a quadrant of which portion *b* has gear teeth. In one revolution of crank *1*, toothed link *3* makes two half-revolutions, one in each direction. The lengths of the motion and dwell periods of link *3* are adjusted by changing the length of rocker arm *2*. The initial position of link *3* is adjusted by turning sector *a* about axis *A* with respect to rocker arm *2*. Concave and concentric surfaces *c* serve to lock link *3* during its dwell periods. To enable the mechanism to pass through its extreme (dead-centre) positions, pins *e* on sector *a* enter slots *d* of link *3*.



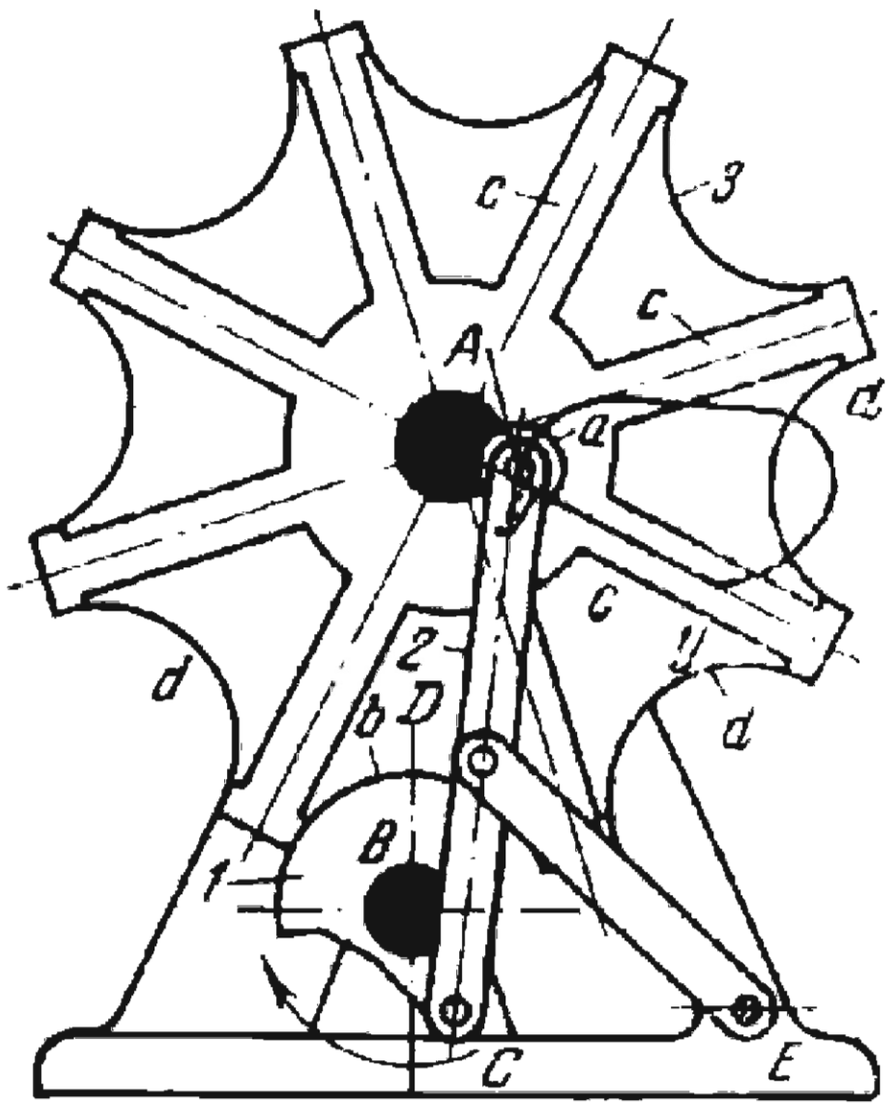
The lengths of the links comply with the conditions: $\overline{AB} = \overline{DC}$ and $\overline{BC} = \overline{AD}$. Link *1* is rigidly attached to worm wheel *7* which rotates about fixed axis *A*. Link *1* is a crank of crossed-crank linkage *ABCD*. Crank *2* of this linkage rotates about fixed axis *D* and is rigidly attached to pin wheel *3* and cam *4*. Geneva wheel *6* rotates about fixed axis *E* and lever *5* turns about fixed axis *F*. Pin wheel *3* has pin *a* and Geneva wheel *6* has slots *b*. During dwell of Geneva wheel *6* the concentric surface of pin wheel *3* engages a concave surface *c* of the Geneva wheel to lock the latter. Worm wheel *7* is driven by worm *8*. Rotation is transmitted from worm wheel *7* to pin wheel *3* and cam *4*. To prevent reverse rotation of link *2* at the extreme (dead-centre) positions, the ends of links *1* and *2* have teeth which periodically mesh with each other. Pin wheel *3* transmits rotation to Geneva wheel *6*, and cam *4* oscillates lever *5*. Spring *9* holds lever *5* in contact with cam *4*.

1753	PIN-WHEEL-LEVER MECHANISM OF AN INVERSE GENEVA WHEEL	GL D



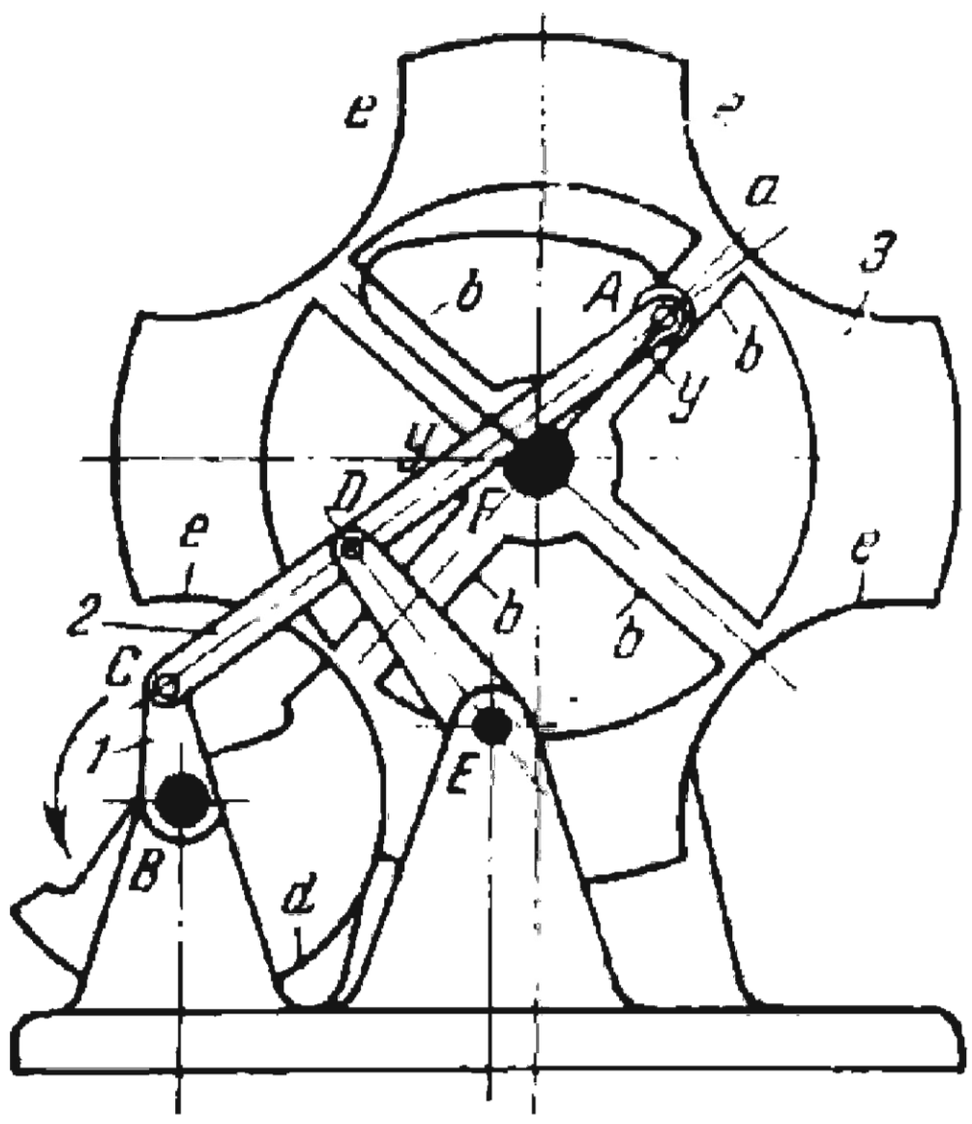
Link *2* of four-bar linkage *BCDE* has pin (roll) *a* at point *A*. This roll engages slots *b* of Geneva wheel *3*. When crank *1* rotates about fixed axis *B*, roll *a* of link *2* drives Geneva wheel *3* intermittently with dwells. The period of wheel dwell corresponds to portion *y-y* of the path of point *A* of roll *a*. Link *4*, driven by crank *1* through gears *5* and *6*, serves to prevent unintentional rotation of wheel *3* during dwell periods by the sliding of concentric surface *c* along concave surfaces *d* of Geneva wheel *3*. In one full revolution of crank *1*, Geneva wheel *3* is indexed through an angle of 40°.

1754	PIN-WHEEL-LEVER MECHANISM OF AN INVERSE GENEVA WHEEL	GL D

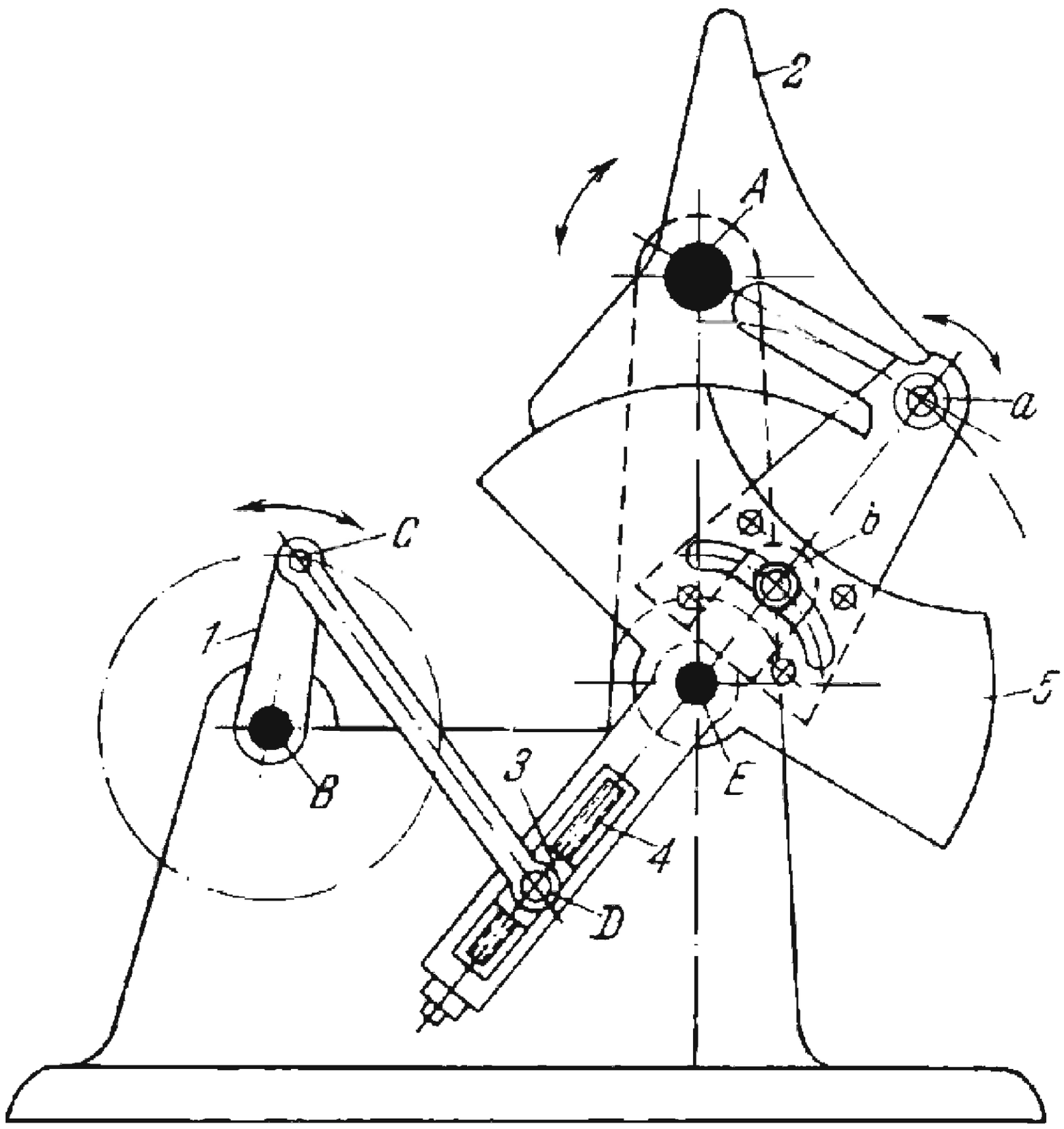


Link *2* of four-bar linkage *BCDE* has pin (roll) *a* at point *A*. This roll engages slots *c* of Geneva wheel *3*. When crank *1* rotates about fixed axis *B*, roll *a* of link *2* drives Geneva wheel *3* intermittently with dwells. The wheel dwell corresponds to portion *y-y* of the path of roll *a*. Concentric surface *b* of crank *1* slides along concave surfaces *d* of Geneva wheel *3* to prevent unintentional rotation of the wheel during its dwell periods. In one full revolution of crank *1*, Geneva wheel *3* is indexed through 22.5°.

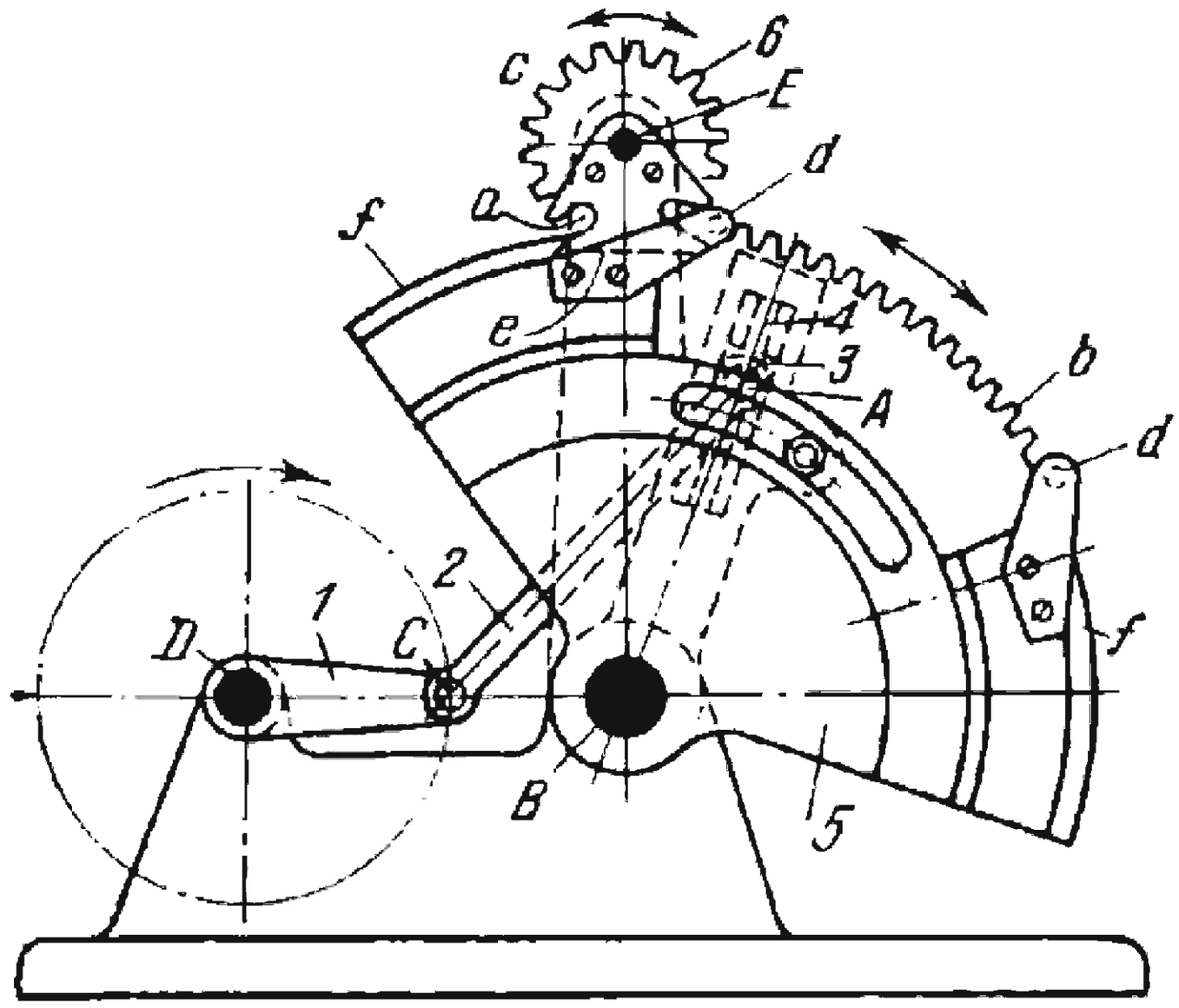
1755	PIN-WHEEL-LEVER MECHANISM OF AN INVERSE GENEVA WHEEL	GL D



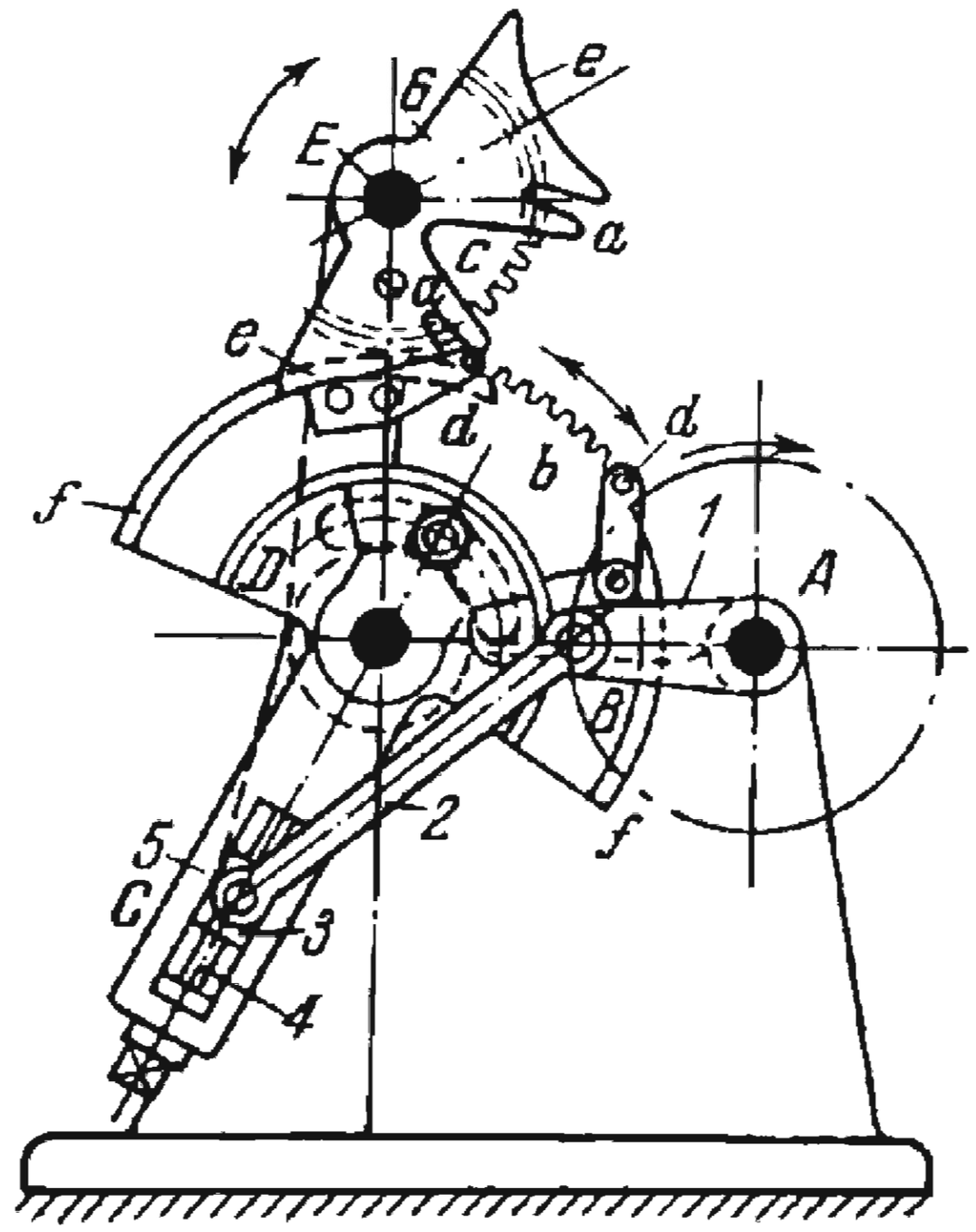
Link *2* of four-bar linkage *BCDE* has pin (roll) *a* at point *A*. This roll engages slots *b* of Geneva wheel *3*. When crank *1* rotates about fixed axis *B*, roll *a* of link *2* drives Geneva wheel *3* intermittently with dwells. The wheel dwell corresponds to approximately straight portions *y-y* of the path of point *A* of roll *a*. These portions make an angle of 90° with each other. Concentric surface *d* of crank *1* slides along concave surfaces *e* of Geneva wheel *3* to prevent unintentional rotation of the wheel during its dwell periods. In one full revolution of crank *1*, Geneva wheel *3* is indexed through 90°.



When crank *1* of four-bar linkage *BCDE* rotates about fixed axis *B*, link *2* oscillates about fixed axis *A*. The motion and dwell periods of link *2* can be varied by changing the distance between turning pairs *D* and *E*. This is done by moving slider *3* along screw *4*. It is necessary, at the same time, to change the angle at which pin *a* is set with respect to line *DE*. This is done by shifting screw *b* in the slot of link *5*.

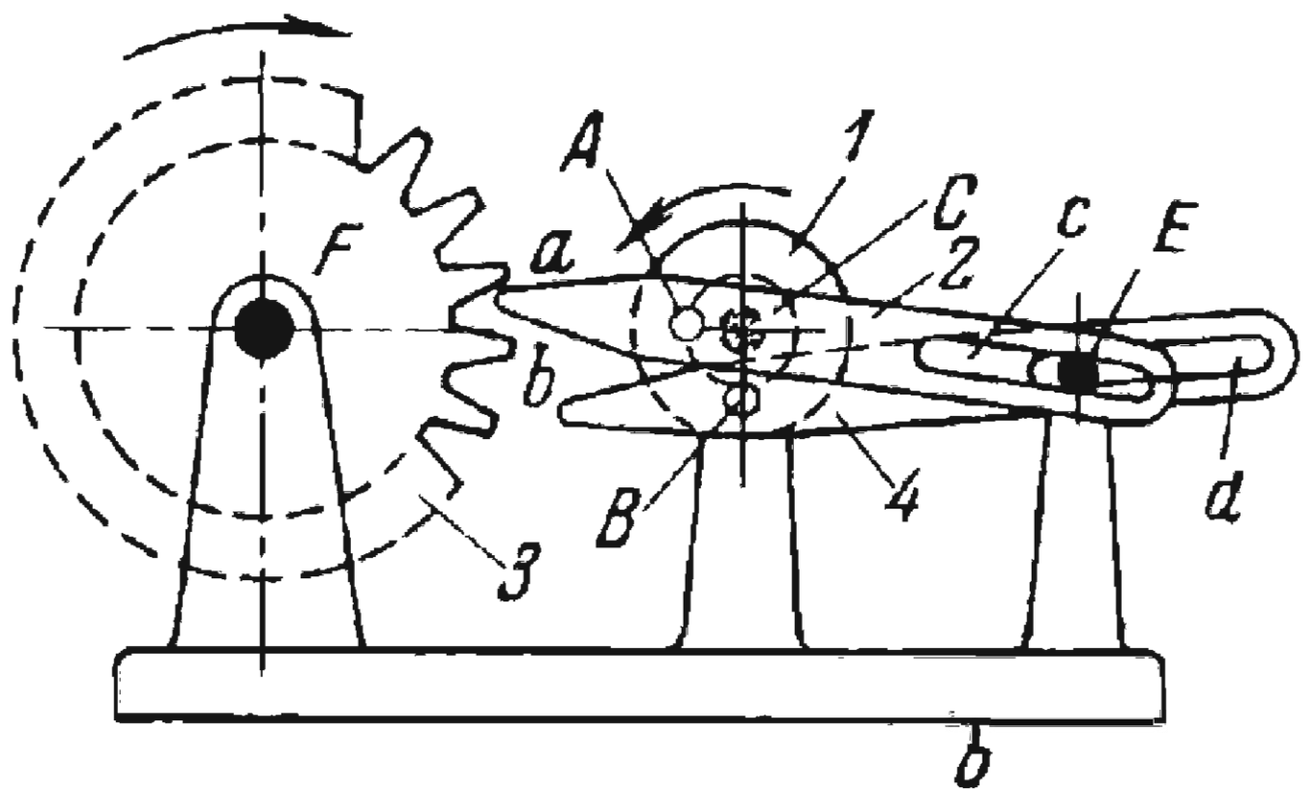


Link *5* of four-bar linkage *DCAB* has gear segment *b* meshing with segment *c* of gear *6*. Link *5* has pins *d* that engage slots *a* of link *6*. When crank *1* rotates about fixed axis *D*, link *6* oscillates with dwells about fixed axis *E* through an angle up to 360°. To avoid impacts in the gearing, gear segments *b* and *c* are brought into and taken out of mesh by the action of pins *d* on slots *a* of link *6*. The motion and dwell periods of link *6* can be varied by changing the distance between turning pairs *A* and *B*. This is done by moving slider *3* along screw *4*. It is necessary, at the same time, to change the angles at which pins *d* are set with respect to line *BA*. Concentric surfaces *f* of link *5* engage concave surface *e* of link *6* to prevent unintentional rotation of link *6* during its dwell periods.

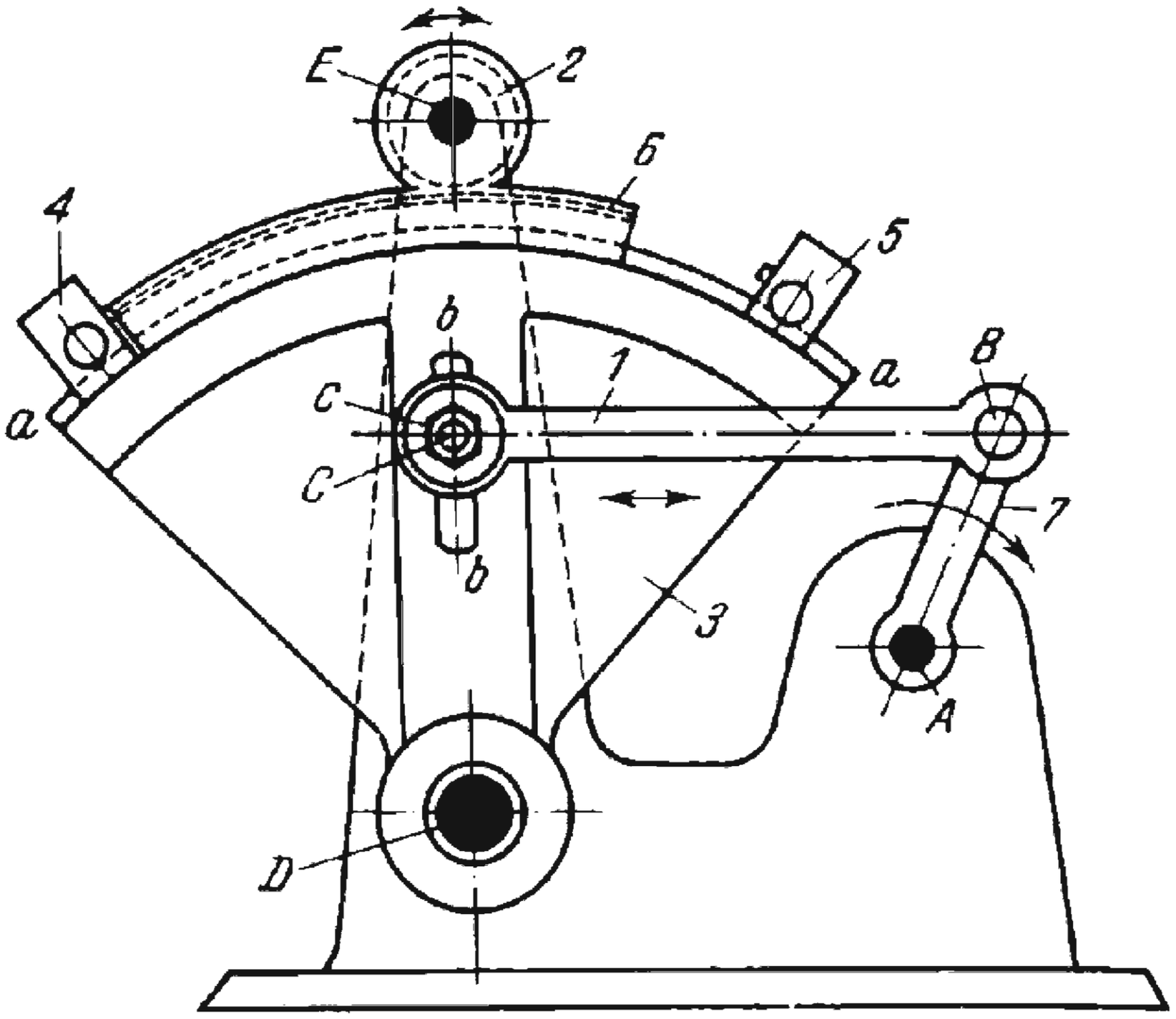


Link *5* of four-bar linkage *ABCD* has gear segment *b* meshing with segment *c* of link *6*. Link *5* has pins *d* that engage slots *a* of link *6*. When crank *1* rotates about fixed axis *A*, link *6* oscillates with dwells about fixed axis *E*. To avoid impacts in the gearing, gear segments *b* and *c* are brought into and taken out of mesh by the action of pins *d* on slots *a* of link *6*. The motion and dwell periods of link *6* can be varied by changing the distance between turning pairs *C* and *D*. This is done by moving slider *3* along screw *4*. It is necessary, at the same time, to change the angles at which pins *d* are set with respect to line *CD*. Concentric surfaces *f* of link *5* engage concave surfaces *e* of link *6* to prevent unintentional rotation of link *6* during its dwell periods.

1759	GEAR-LEVER DWELL MECHANISM	GL D

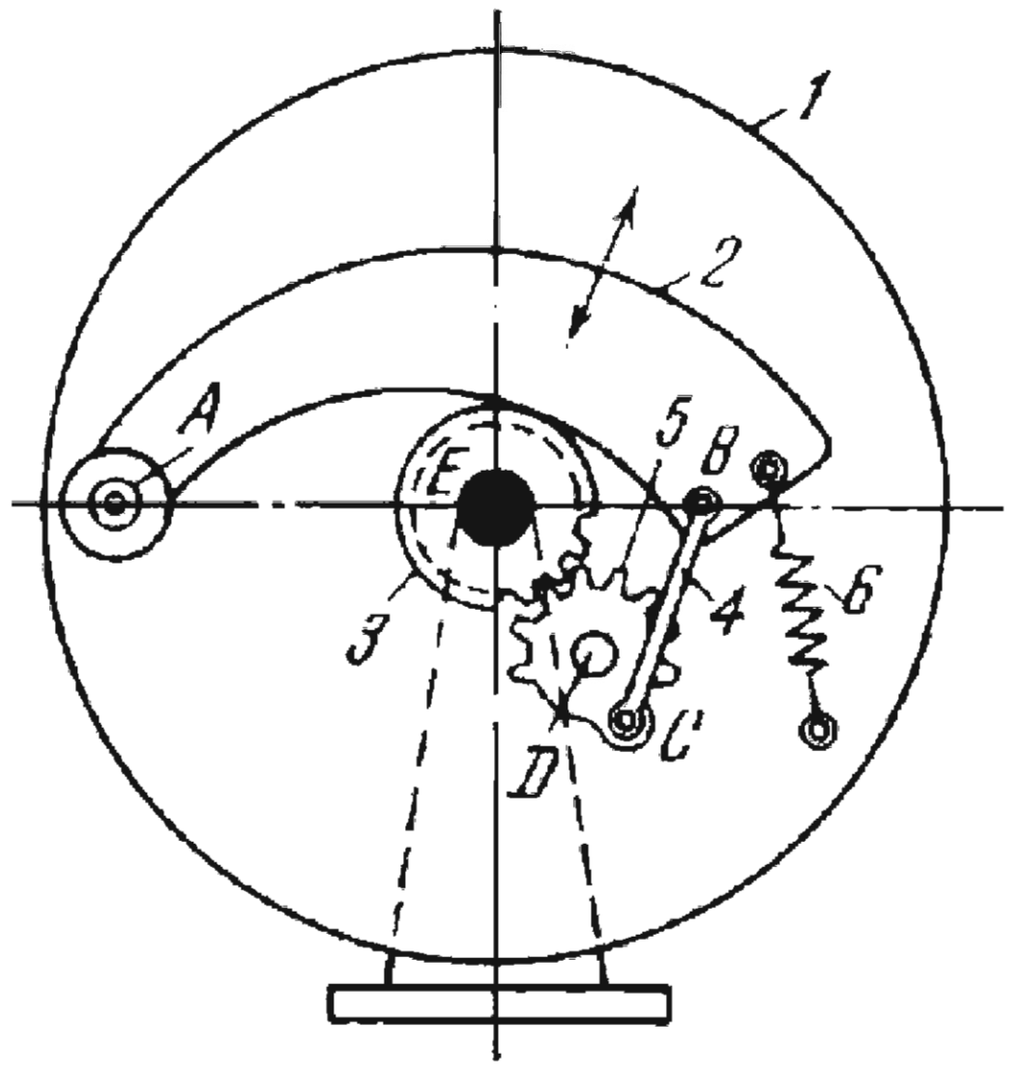


Link *1* is connected by turning pairs *A* and *B* to links *2* and *4*. Links *2* and *4* have slots *c* and *d* that slide along fixed pin *E*. These links have teeth *a* and *b* at their ends. Gear *3* rotates about fixed axis *F*. When link *1* rotates about fixed axis *C*, teeth *a* and *b* of links *2* and *4* alternately engage successive teeth of gear *3*, rotating the gear intermittently. In one complete revolution of link *1*, gear *3* is indexed through an angle of $\alpha = 720°/z$, where z is the number of teeth of gear *3*.



Link *7* rotates about fixed axis *A* and transmits oscillating motion to link *3* through connecting rod *1*. Link *3* oscillates about fixed axis *D* and is designed as a quadrant. Arc-shaped gear rack *6* slides along guides *a-a* of link *3* and meshes with gear *2* which rotates about fixed axis *E*. Circular rack *6* slides freely along guides *a-a* and is driven by stops *4* and *5* clamped on link *3*. The mechanism converts rotation of crank *7* into intermittent oscillating motion with dwells of gear *2*. The dwell periods and angle of rotation of gear *2* can be varied by shifting stops *4* and *5* along guides *a-a* and by adjusting point *C* of turning pair *c* along slot *b-b* of quadrant *3*.

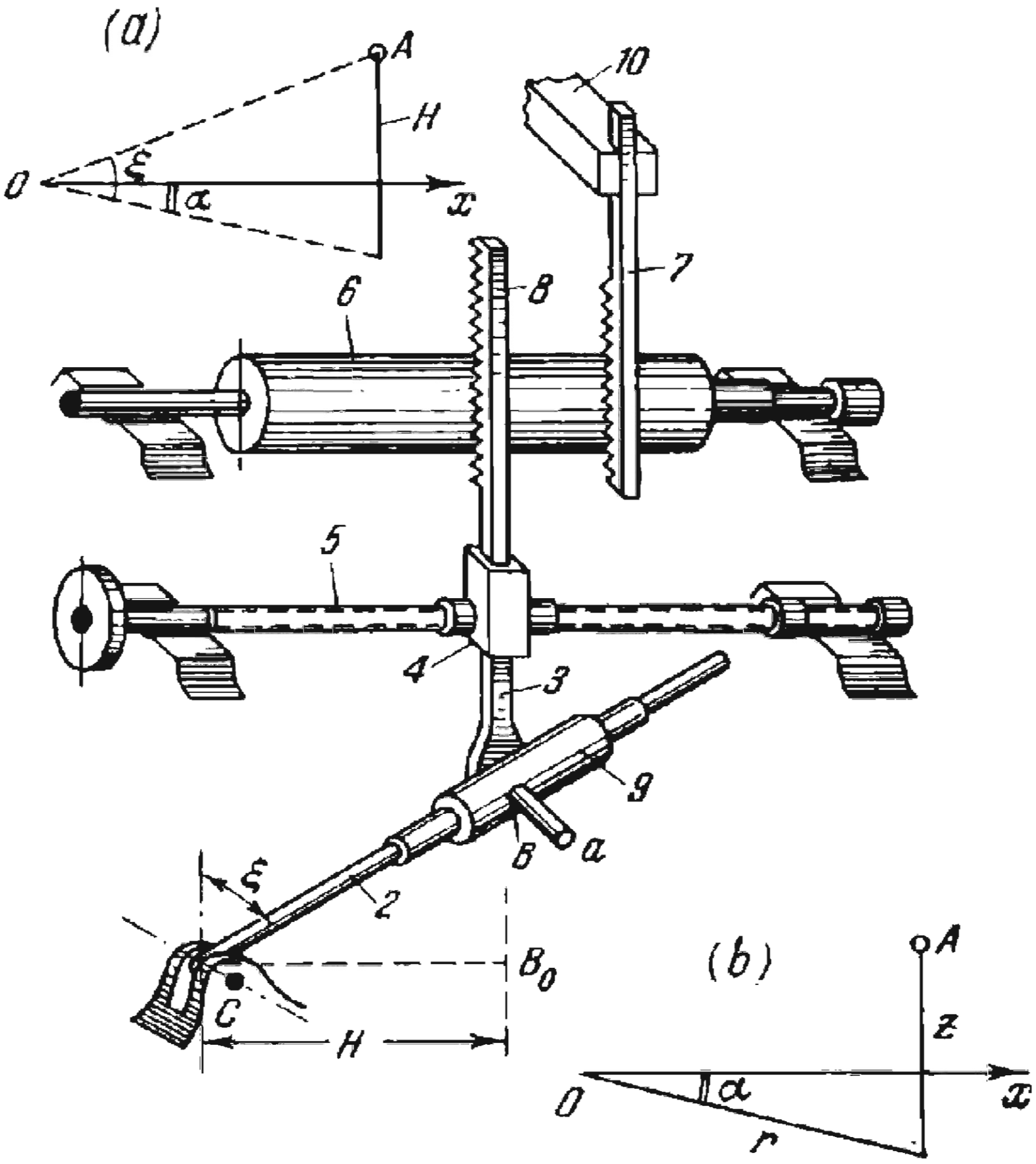
1761	GEAR-LEVER MECHANISM OF A PLANE CENTRIFUGAL GOVERNOR	GL G



Heavy link *2* turns about axis *A* of disk *1*. Link *4* is connected by turning pairs *B* and *C* to links *2* and *5*. Link *5* is designed as a gear turning about axis *D* of disk *1*. Gear *5* meshes with gear *3* which rotates about fixed axis *E*. When the speed of disk *1* changes, link *2* is forced outward by centrifugal force or inward by spring *6* about axis *A*. Through link *4* and gear *5*, link *2* turns gear *3* with respect to disk *1*. Spring *6* is attached with one end to link *2* and the other to disk *1*.

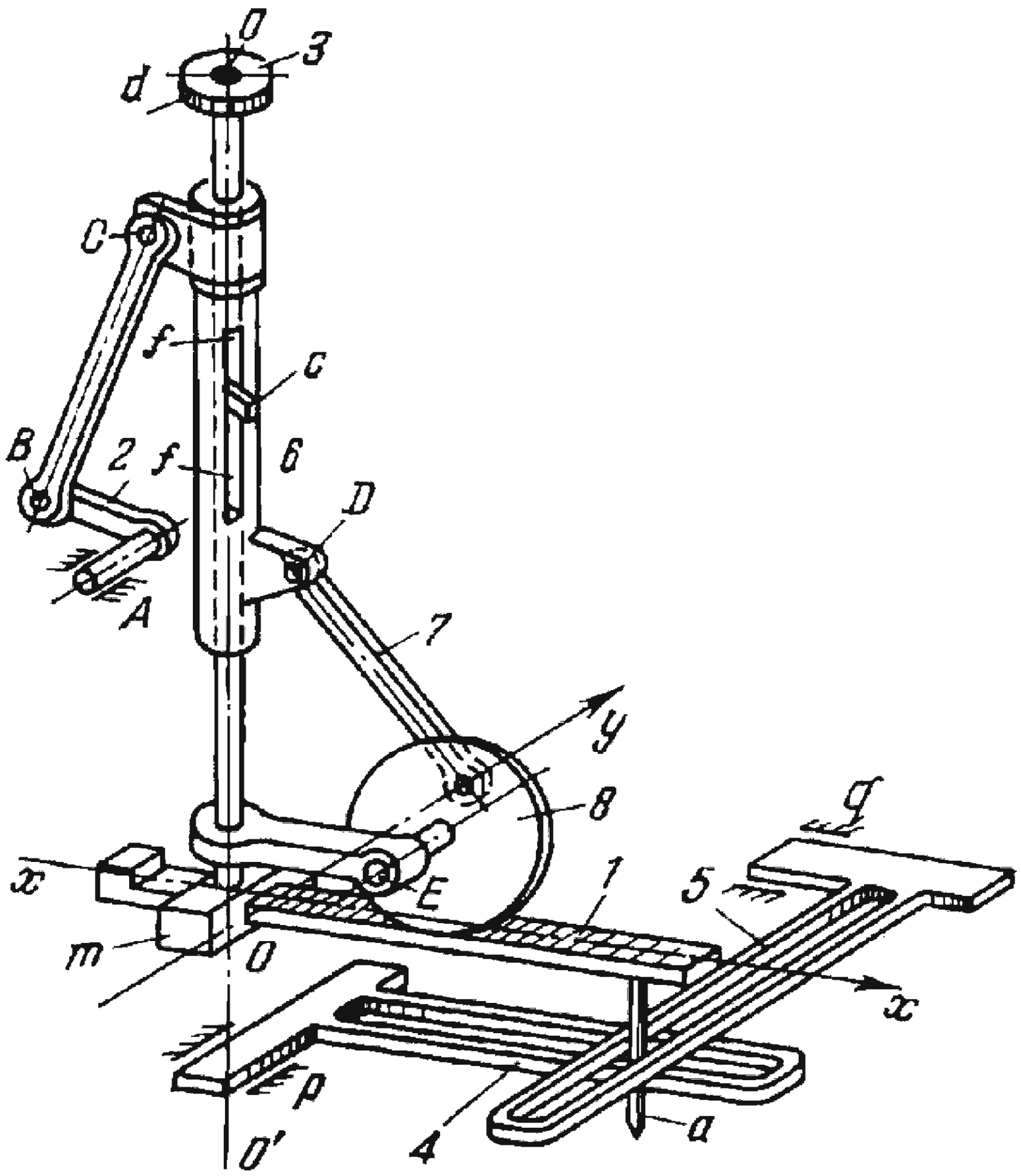
8. MECHANISMS FOR MATHEMATICAL OPERATIONS (1762 and 1763)

1762	GEAR-LEVER COORDINATE CONVERSION MECHANISM	GL MO



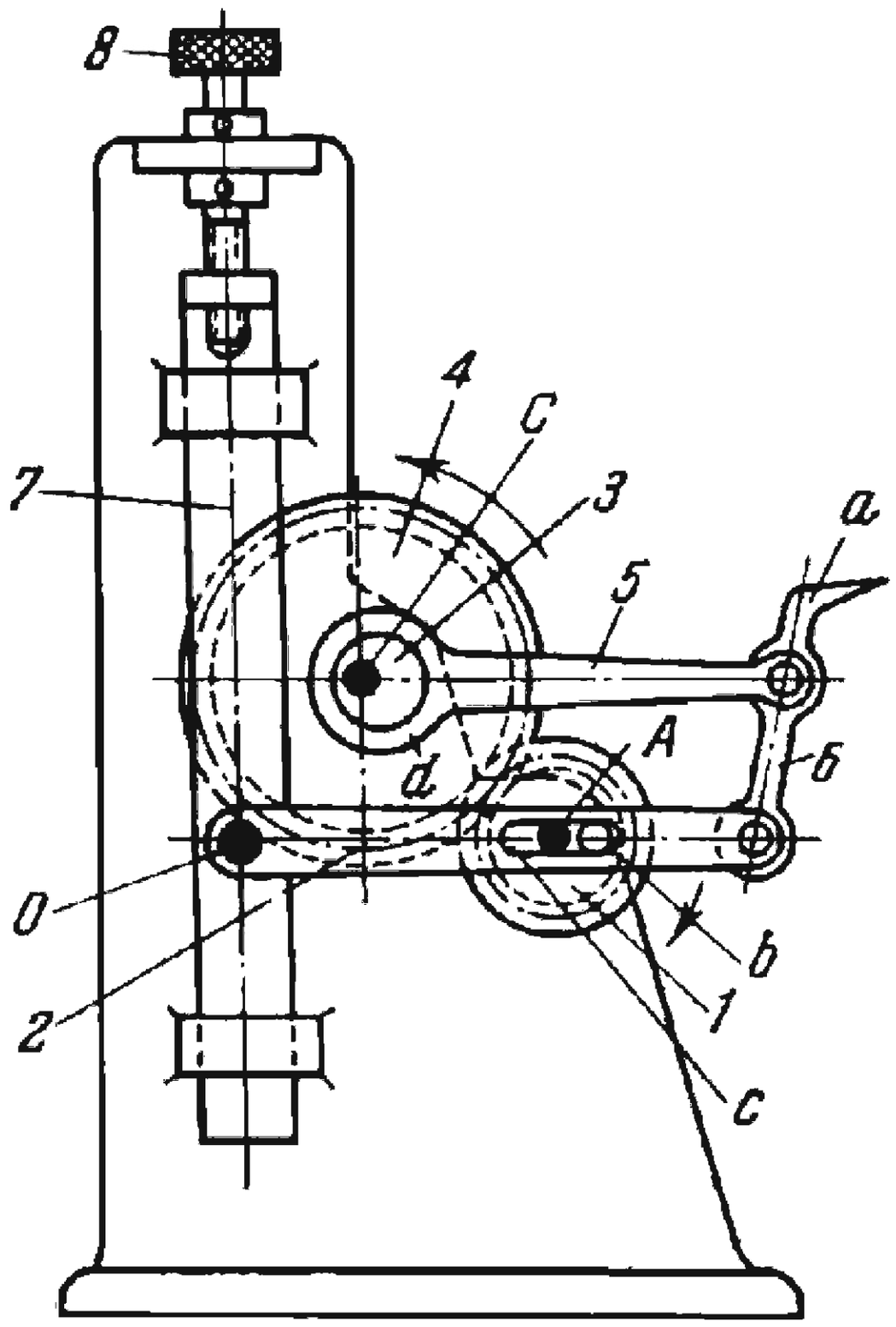
Link *2* turns about fixed axis *C*. Link *3* has pin *a* which is connected by a turning pair to slider *9* moving along the axis of link *2*. Link *3* is connected by a sliding pair to link *4* which is designed as a nut moving along screw *5*. Link *3* has gear rack *8* which meshes with long gear *6*. Gear *6* also meshes with gear rack *7* which slides in fixed guide *10*. The mechanism converts the system of coordinates shown in Fig. *a* to the one shown in Fig. *b*. The conversion of a system with the coordinates α, ξ and H into a system with α, r and z is carried out according to the transformation formulas $z = H$ and $r = H \cot \xi$. Angle ξ is entered by turning link *2*. Height H is entered by turning screw *5*. The vertical displacement of rack *8* is $B_0B = H \cot \xi$. Rack *8* drives gear *6* which, in turn, displaces rack *7* whose displacement equals

$$B_0B = H \cot \xi = r.$$



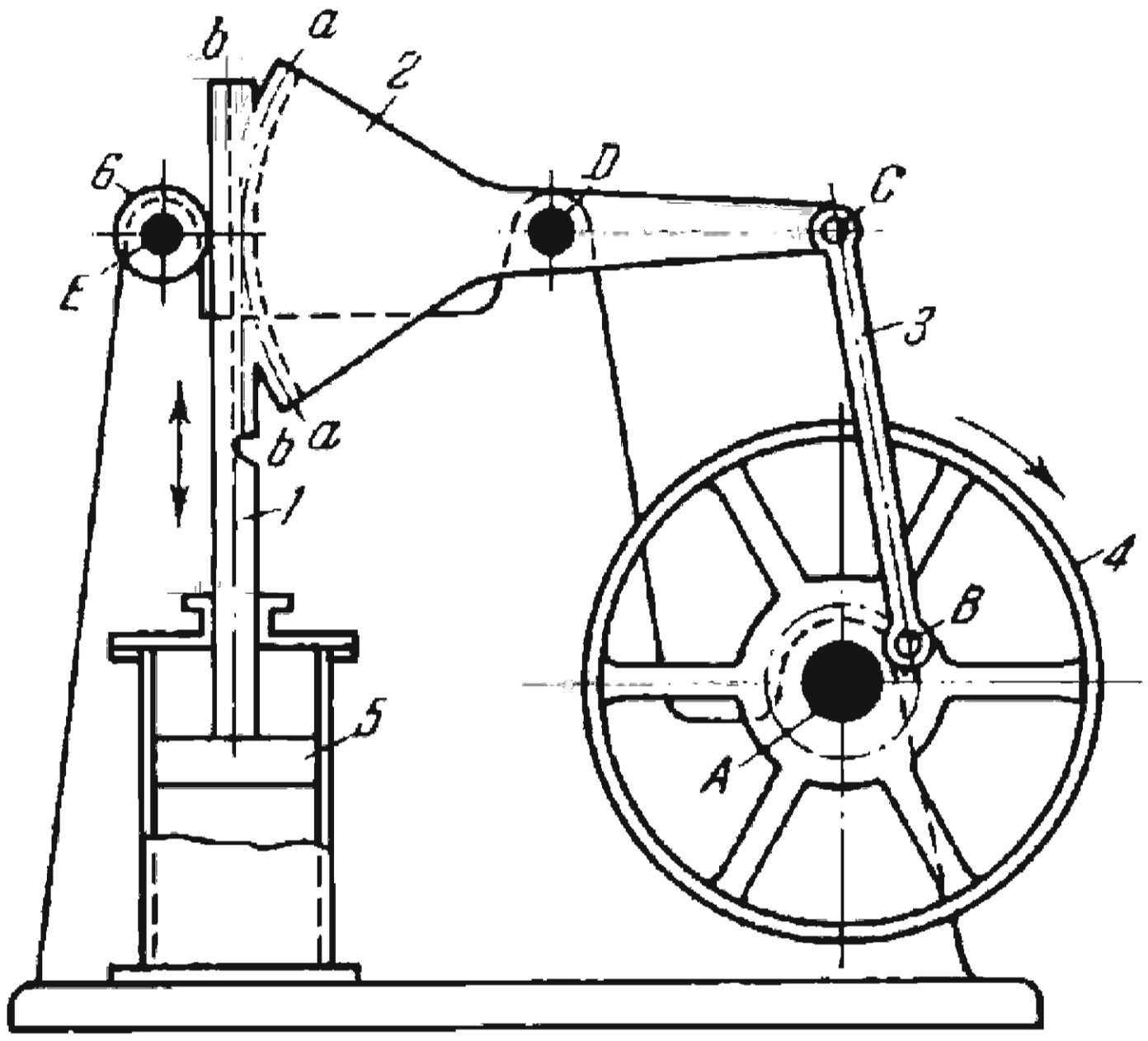
Links *4* and *5* slide along fixed guides *p* and *q* whose axes are parallel to axes *y* and *x*. Pin *a* of link *1* slides along the slots of links *4* and *5*. Link *1* slides in guide *m* and turns about axis *O-O*. Link *1* is moved in guide *m* by slider-crank linkage *ABC* which moves slider *6* along axis *O-O* of link *3*. Through intermediate link *7* slider *6* turns gear *8* about axis *E*. Gear *8* meshes with the gear rack of link *1* and rotation of the gear leads to the sliding of link *1* in guide *m*. Link *1* is turned about axis *O-O* by turning head *d* of link *3*. Pin *c* of link *3*, sliding along slot *f-f* of slider *6*, turns the slider. The mechanism converts polar coordinates into rectangular (Cartesian) coordinates and vice versa. Coordinate *x* is entered by the position of link *5*; coordinate *y* by the position of link *4*. Polar coordinate α is entered by turning link *3* about axis *O-O*; polar coordinate *r* by turning link *2*.

1764	GEAR-LEVER OPERATING CLAW MECHANISM OF A MOTION PICTURE CAMERA	GL OC



Gear *1* rotates about fixed axis *A* and meshes with gear *4* which rotates about fixed axis *C*. Rocker arm *2* turns about fixed axis *O*. Link *5* has collar *d* encircling eccentric *3*. Pin *b*, secured on gear *1*, slides along slot *c* of rocker arm *2*. Claw *a* is a part of link *6*. When gear *1* rotates about axis *A*, the tip of claw *a* describes a complex curve in which it is inserted into a perforation of the film, advances the film and is withdrawn from the perforation. Axis *O* of rocker arm *2* is mounted on bar *7*. The path described by the tip of claw *a* can be varied by changing the position of point *O*. This is done by adjusting bar *7* by screw *8*.

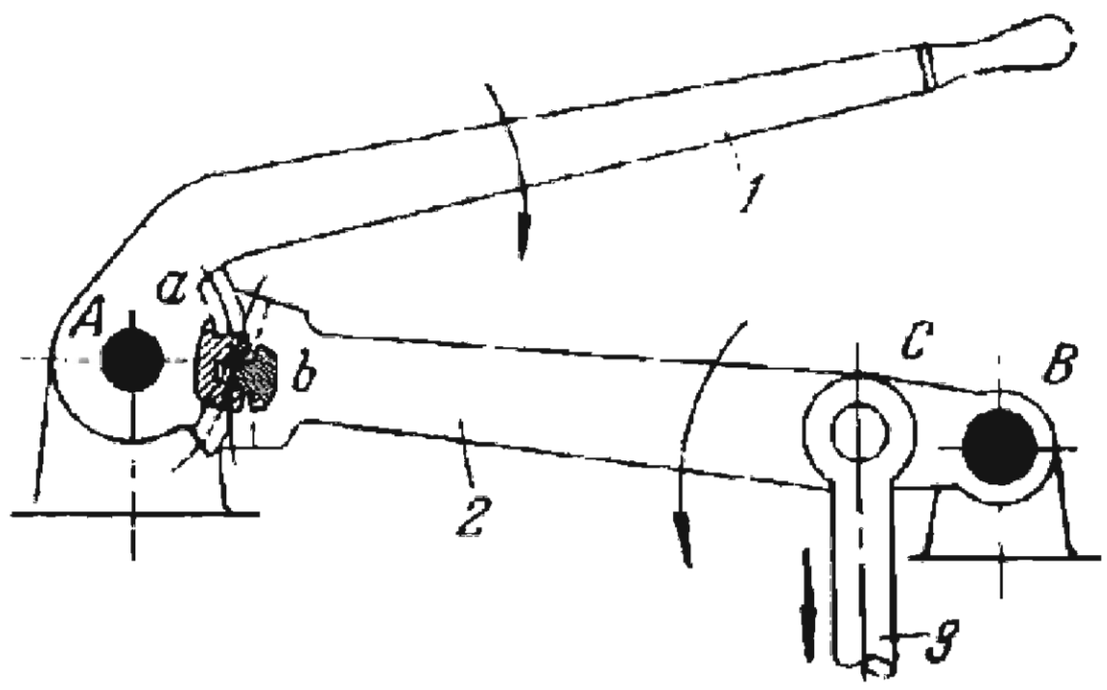
1765	GEAR-LEVER RACK-TYPE BEAM ENGINE	GL PM



Rocker arm *2* of four-bar linkage *ABCD* has gear segment *a-a* which meshes with gear rack *b-b* on rod *1* of piston *5*. Rack *1* reciprocates and thereby oscillates rocker arm *2* about fixed axis *D*. Through connecting rod *3*, rocker arm *2* rotates main shaft *A* of the engine together with flywheel *4*. Rod *1* is supported by roll *6* which rotates about fixed axis *E*.

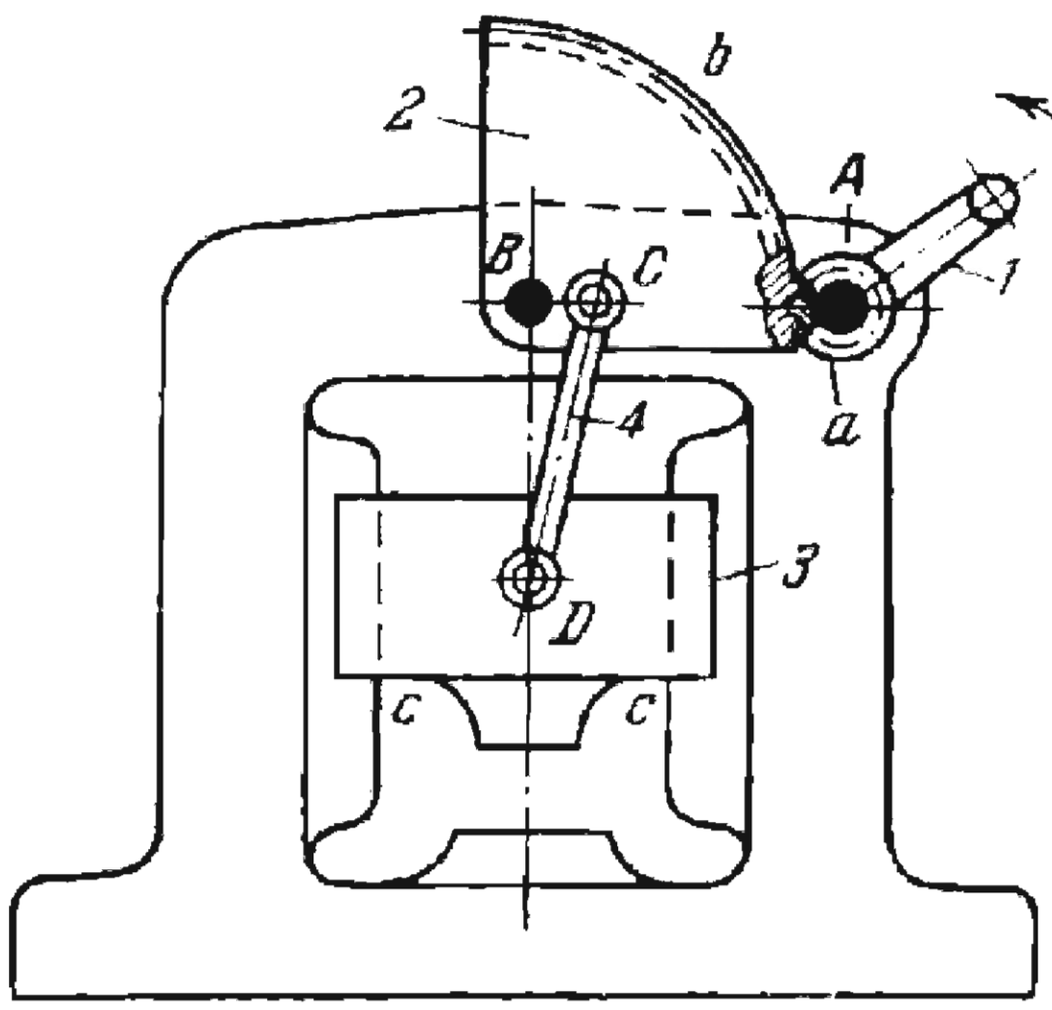
11. HAMMER, PRESS AND DIE MECHANISMS (1766, 1767 and 1768)

1766	LEVER-OPERATED HAND PRESS WITH GEAR SEGMENTS	GL HP



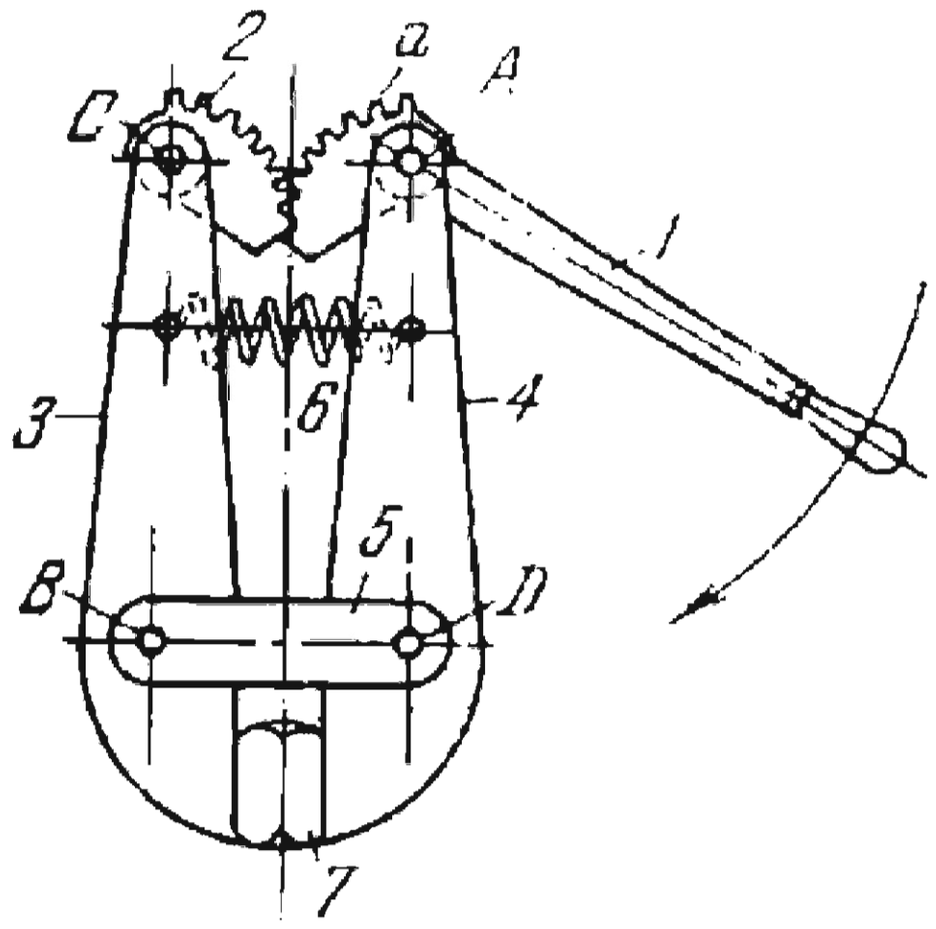
Meshing gear segments *a* and *b* belong to links *1* and *2* which turn about fixed axes *A* and *B*. Link *3*, the ram of the press, is connected by turning pair *C* to link *2*. The pressing force is transmitted from hand-lever *1* through gear segments *a* and *b* and link *2* to ram *3*.

1767	GEAR-LEVER PRESS DRIVE MECHANISM	GL HP



Lever *1*, rotating about fixed axis *A*, is rigidly attached to pinion *a* which meshes with link *2*. Link *2* turns about fixed axis *B* and is designed as a quadrant with gear segment *b*. Connecting rod *4* is connected by turning pairs *C* and *D* to link *2* and to press slide *3* which moves along fixed guides *c-c*. When lever *1* is rotated, first in one direction and then in the other, slide *3* is reciprocated through intermediate links *2* and *4*.

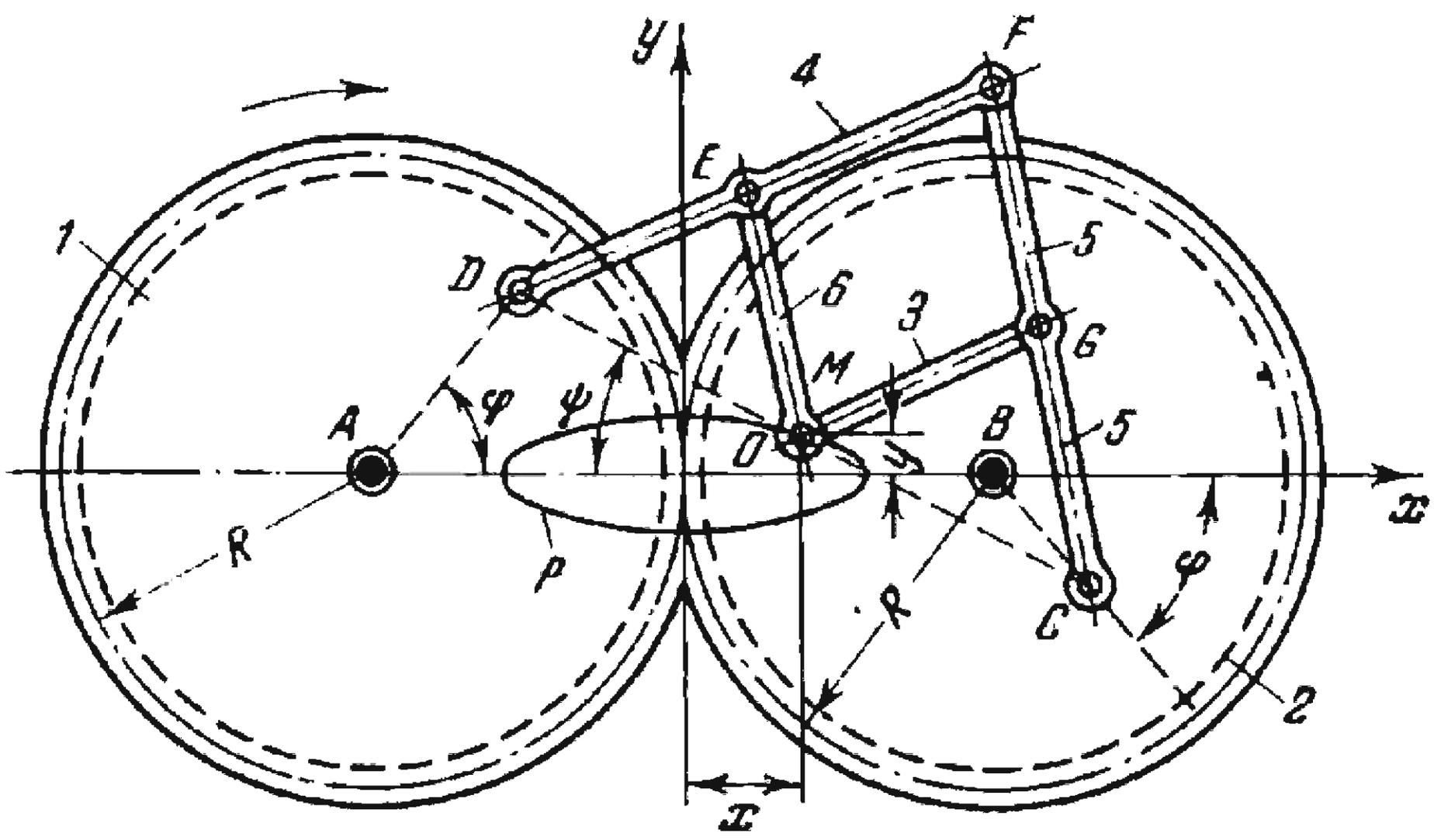
1768	LEVER-OPERATED HAND PRESS WITH NONCIRCULAR GEAR SEGMENTS	GL HP



Noncircular gear segment *a* is rigidly attached to lever *1* which turns about axis *A*. Gear segment *a* meshes with noncircular gear segment *2* which turns about axis *C*. Links *3* and *4* turn about axes *B* and *D* of fixed link *5*. When noncircular gear segments *a* and *2* turn about axes *A* and *C*, links *3* and *4* turn about axes *B* and *D*, and press workpiece *7* between their jaws. Spring *6* opens the jaws and returns the press to its initial position.

12. MECHANISMS FOR GENERATING CURVES
(1769 through 1773)

1769	GERSHGORIN GEAR-LEVER ELLIPSOGRAPH	GL Ge

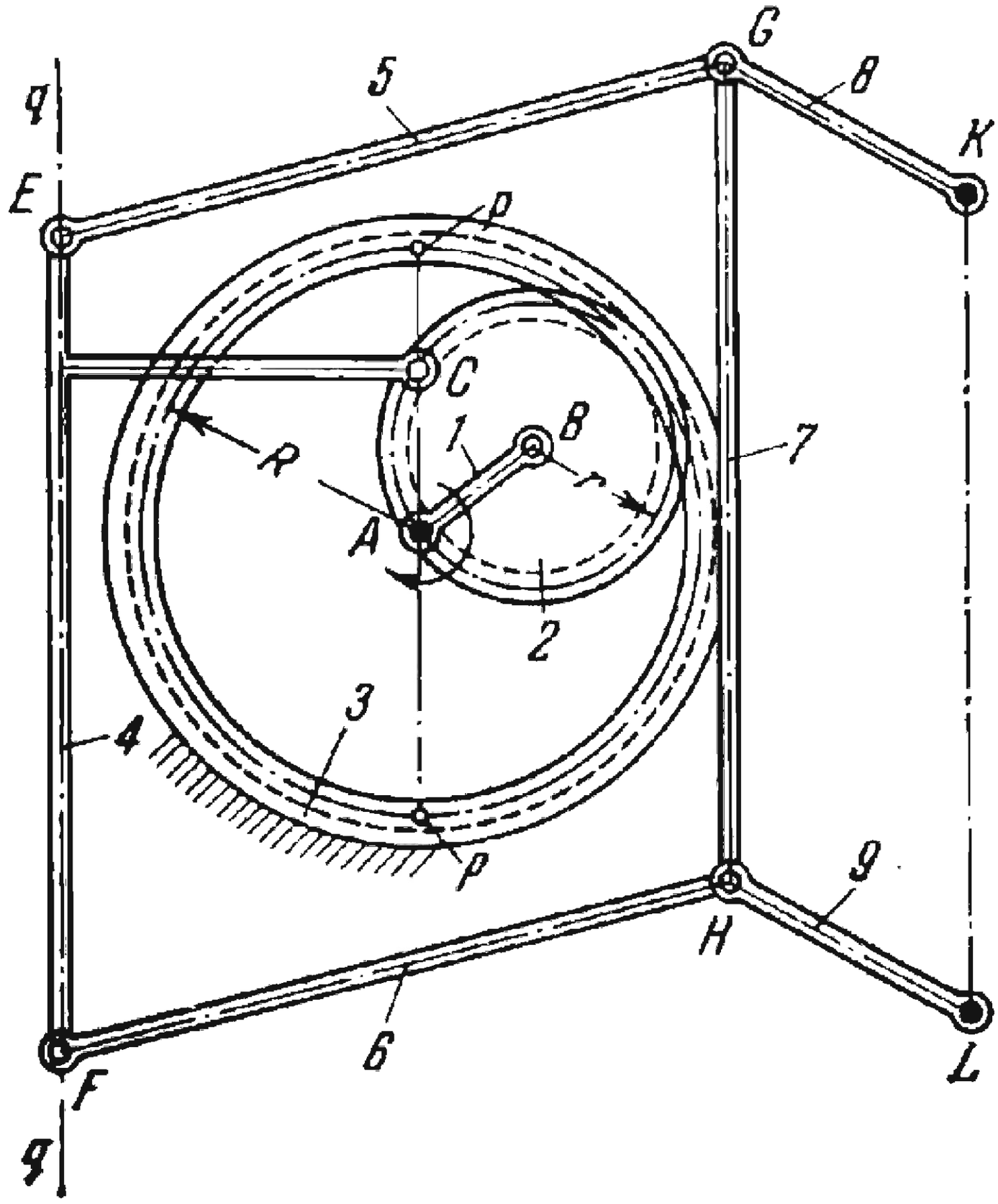


The lengths of the links comply with the condition: $\overline{DE} = \overline{EF} = \overline{FG} = \overline{GC} = \overline{EM} = \overline{MG}$. Figure $EFGM$ is a rhombus linkage. Two identical meshing gears, *1* and *2*, of radius R, rotate about fixed axes A and B, and are connected by turning pairs D and C to links *4* and *5*. Lines AD and BC make angles of φ with axis Ox. Links *4* and *5* are connected together by turning pair F and to links *6* and *3* by turning pairs E and G. Links *6* and *3* are connected together by turning pair M. When gear *1* rotates about axis A, point M describes an ellipse with the equation

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

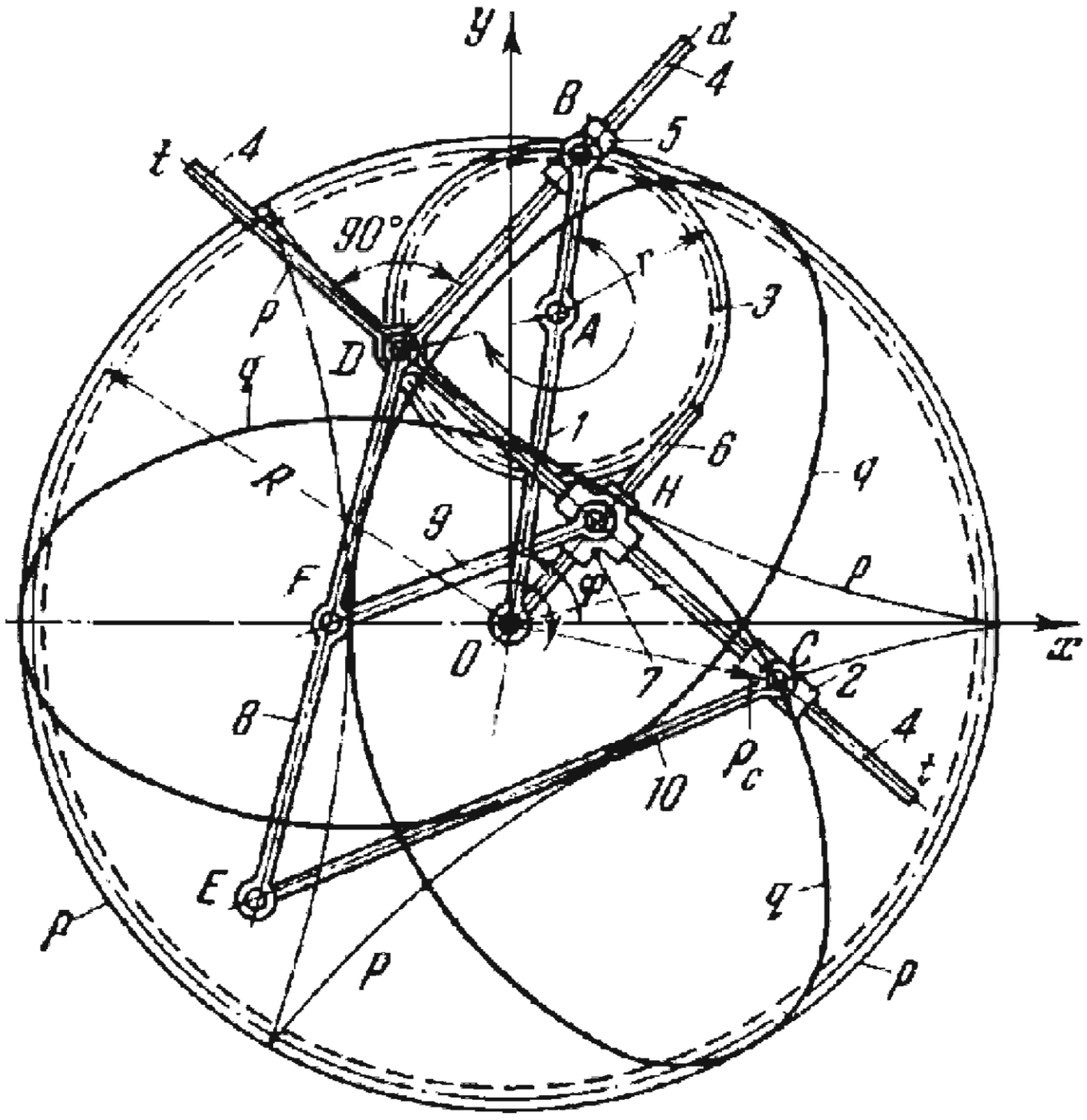
where $a = \dfrac{\overline{AD} + \overline{BC}}{2}$ and $b = \dfrac{\overline{AD} - \overline{BC}}{2}$.

1770	ARTOBOLEVSKY GEAR-LEVER MECHANISM HAVING A LINK WITH RECTILINEAR TRANSLATION	GL Ge



The lengths of the links comply with the conditions: $\overline{AB} = \overline{BC} = r$, $R/r = 2$, $\overline{EG} = \overline{FH}$, $\overline{GK} = \overline{HL}$ and $\overline{EF} = \overline{GH} = \overline{KL}$. The mechanism is based on Cardan circles consisting of gear *2* of radius *r* rolling in internal gear *3* of radius *R*. Link *1* rotates about fixed axis *A* and is connected by turning pair *B* to gear *2*. Point *C* of gear *2* describes straight line *p-p* passing through point *A*. Gear *2* is connected by turning pair *C* to link *4* of the translator mechanism which forms two parallelograms, *KGHL* and *GEFH*. When link *1* rotates about axis *A*, link *4* has rectilinear translational motion and axis *EF* of link *4* slides along straight line *q-q* which is parallel to line *KL*.

Links *8* and *9* turn about fixed axes *K* and *L*.

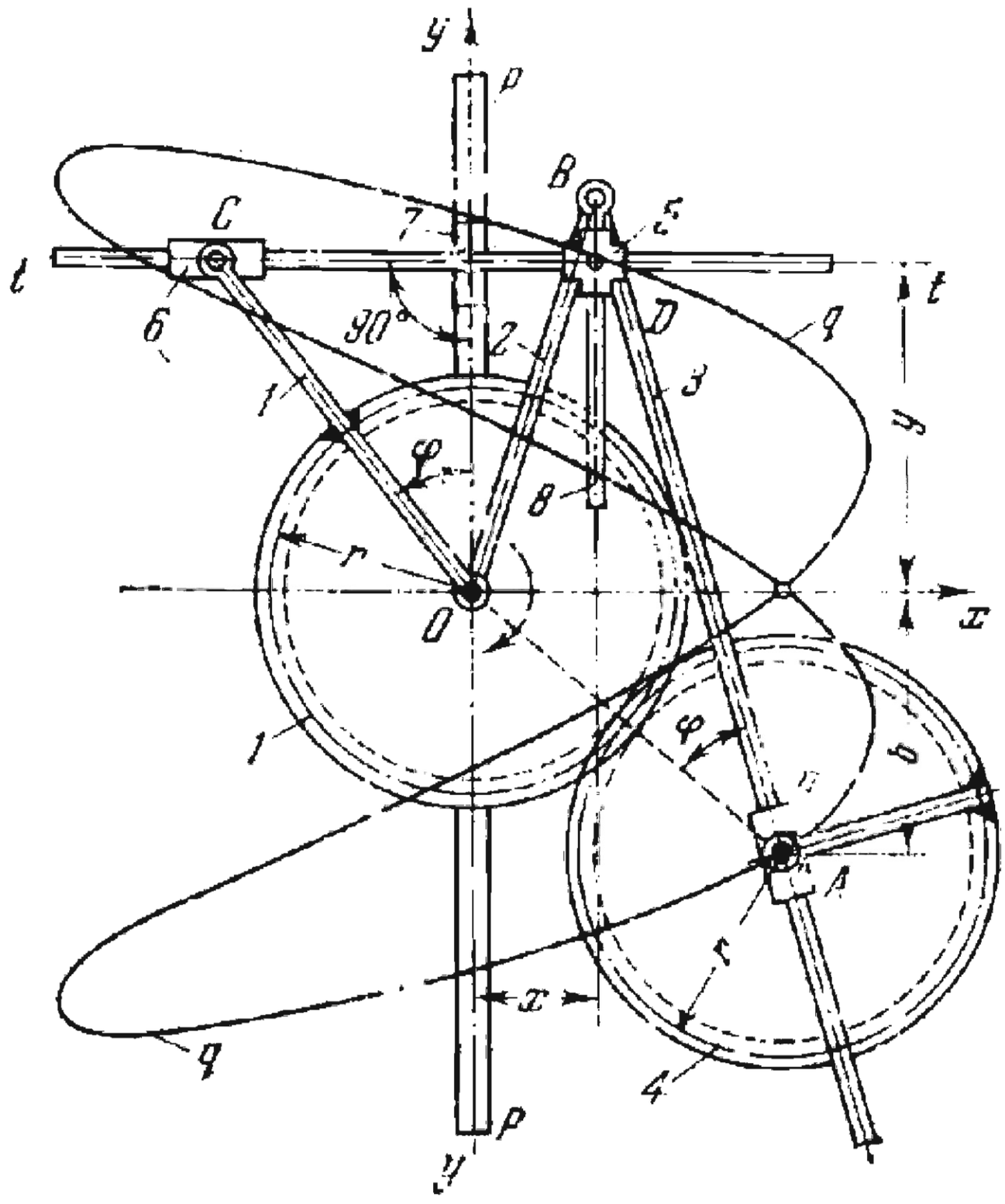


The lengths of the links comply with the conditions: $r/R = 1/3$, $\overline{OA} = R - r$, $\overline{OB} = R$, $\overline{DF} = \overline{FH} = \overline{FE} = \overline{EC}/2$. Gear *3* of radius *r* rolls inside fixed internal gear *p-p* of radius *R* and is connected by turning pair *A* to link *1* which rotates about fixed axis *O*. Link *1* is connected by turning pair *B* to slider *5* which moves along cross-piece *Dd* of link *4*. Link *4* is connected by turning pair *D* to gear *3* and its cross-piece *t-t* moves in slider *2* and in cross-shaped slider *7* which has guides with axes perpendicular to each other. Link *6* turns about axis *O* and moves in slider *7*. Link *8* is connected by turning pairs *D*, *F* and *E* to links *4*, *9* and *10*. Links *9* and *10* are connected by turning pairs *H* and *C* to sliders *7* and *2*. When link *1* rotates about axis *O*, point *C* describes trifolium *q-q* with the equation

$$\rho_C = \overline{OC} = 5r^2 + 4r^4 \cos 3\varphi$$

where φ is the angle between axis *OA* and axis *Ox*.

ARTOBOLEVSKY GEAR-LEVER MECHANISM FOR TRACING VIRTUAL PARABOLAS

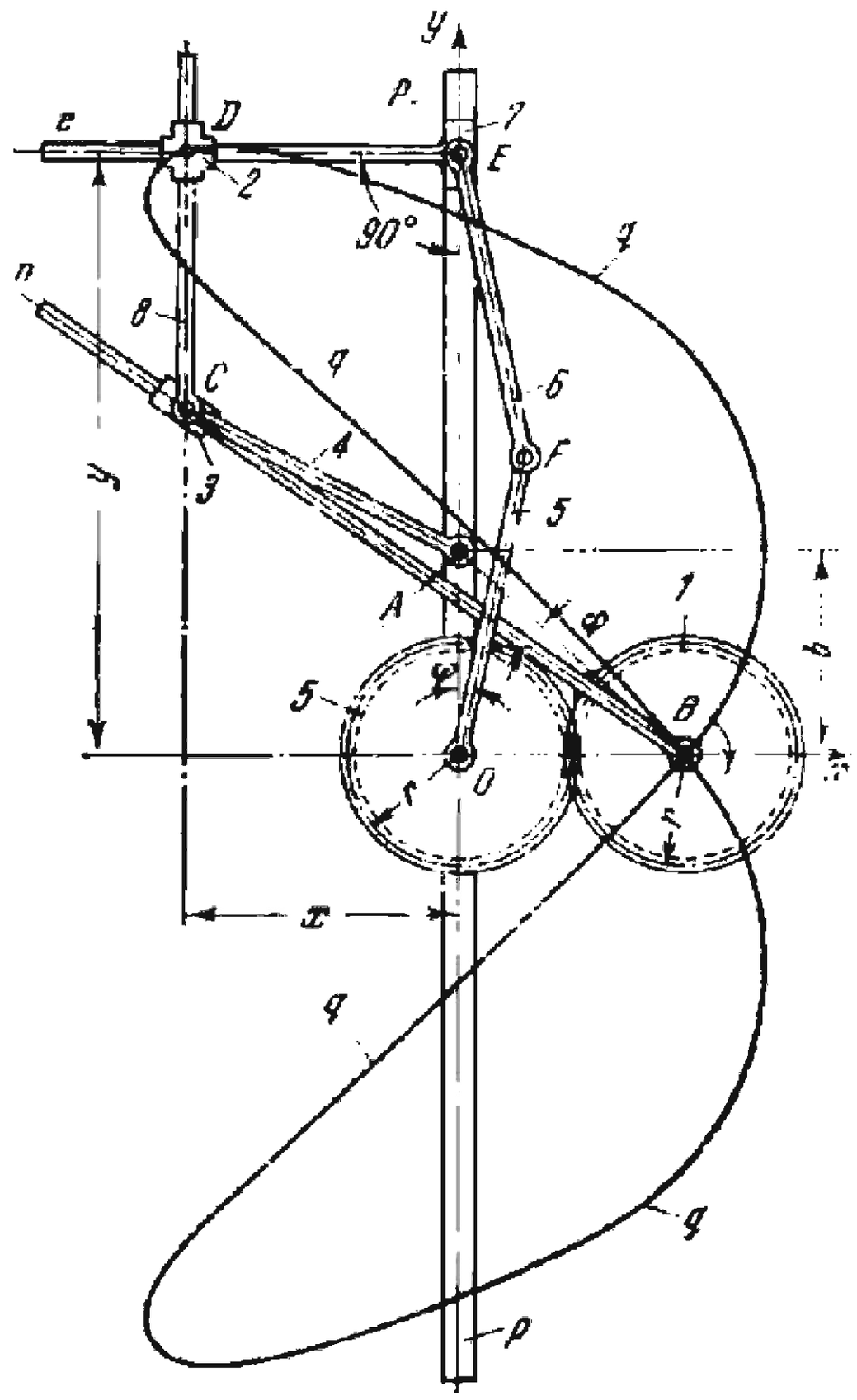


The lengths of the links comply with the condition: $\overline{OB} = \overline{OC} = \overline{OA} = a$. Gears *1* and *4* are of equal radius *r*. Gear *1* rotates about fixed axis *O* and meshes with gear *4* which rotates about fixed axis *A*. Lever *OC*, rigidly attached to gear *1*, is connected by turning pair *C* to slider *6* which moves along cross-piece *t-t* of slider *7*. Slider *7* moves along fixed guides *p-p* whose axis coincides with axis *Oy*. Link *2* turns about axis *O* and is connected by turning pairs *B* to links *3* and *8*. Link *8* moves in cross-shaped slider *5* which has guides with axes perpendicular to each other. Link *3* is connected by a sliding pair to slider *n* which is rigidly attached to gear *4*. When gear *1* rotates about axis *O*, point *D* describes virtual parabola *q-q* with the equation

$$[a^2x - (a^2 - 2y^2)\sqrt{a^2 - b^2}]^2 = 4b^2y^2(a^2 - y^2)$$

where *b* is a constant dimension of the mechanism.

1773	ARTOBOLEVSKY GEAR-LEVER MECHANISM FOR TRACING VIRTUAL PARABOLAS OF VINCENTIO	GL Ge



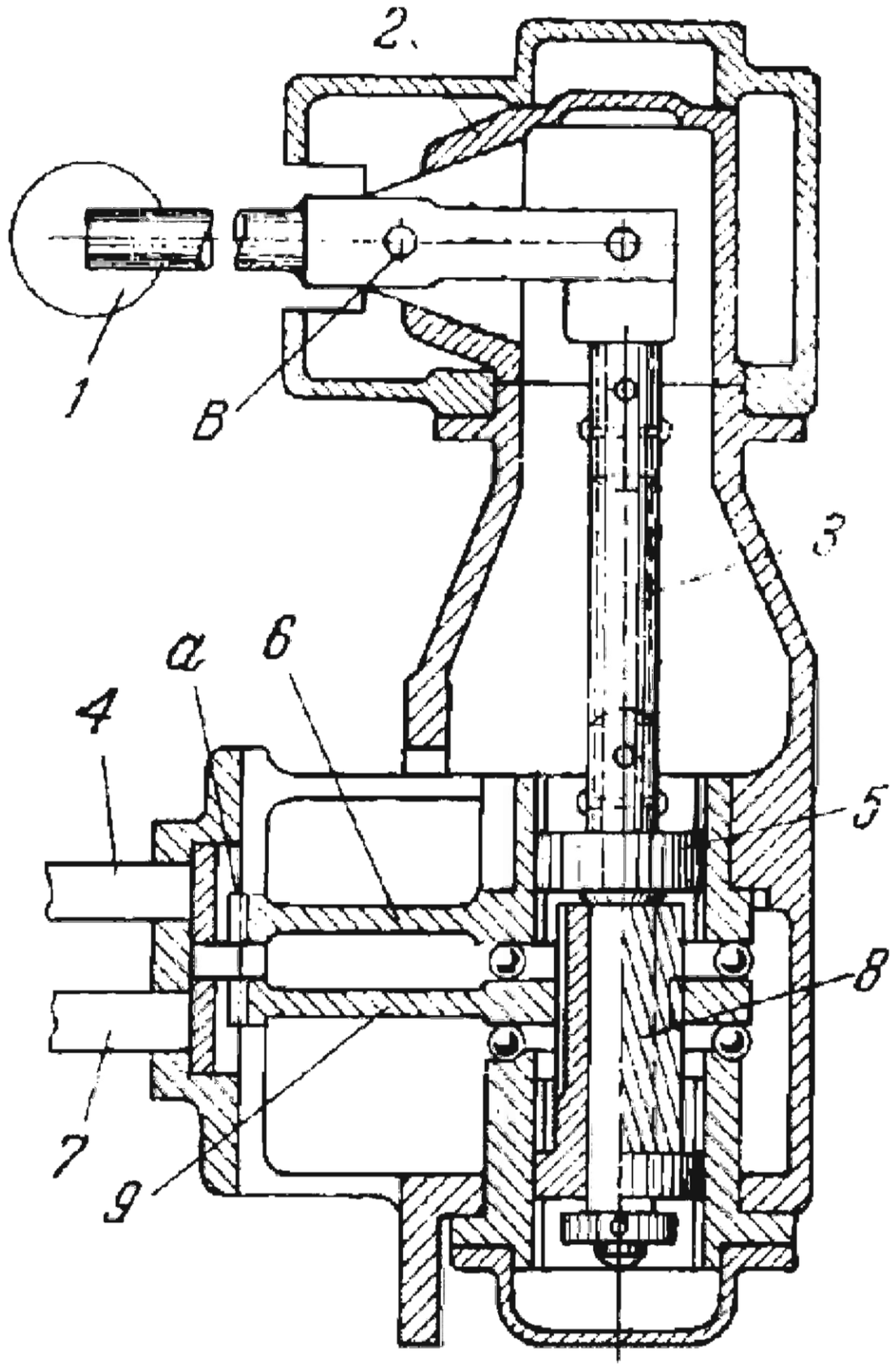
The lengths of the links comply with the condition: $\overline{AC} = \overline{AB} = \overline{OF} = \overline{FE} = a$. Gears *1* and *5* are of equal radius r. Gear *1* rotates about fixed axis B and meshes with gear *5* which rotates about fixed axis O. Lever Bn, rigidly attached to gear *1*, is connected by a sliding pair to slider *3* which, in turn, is connected by turning pair C to link *4* turning about fixed axis A. Link *8* is connected by turning pair C to slider *3* and moves in cross-shaped slider *2* which has guides with axes perpendicular to each other. Slider *2* moves along cross-piece Ee of slider *7* which moves along fixed guides p-p whose axis coincides with axis Oy. Link *6* is connected by turning pairs E and F to slider *7* and lever OF which is rigidly attached to gear *5*. When gear *1* rotates about axis B, point D of slider *2* describes virtual parabola q-q of Vincentio with the equation

$$[2r^2x + (2r^2 - y^2)\sqrt{r^2 - b^2}]^2 = b^2y^2(4r^2 - y^2)$$

where b is a constant dimension of the mechanism.

13. SWITCHING, ENGAGING AND DISENGAGING MECHANISMS (1774)

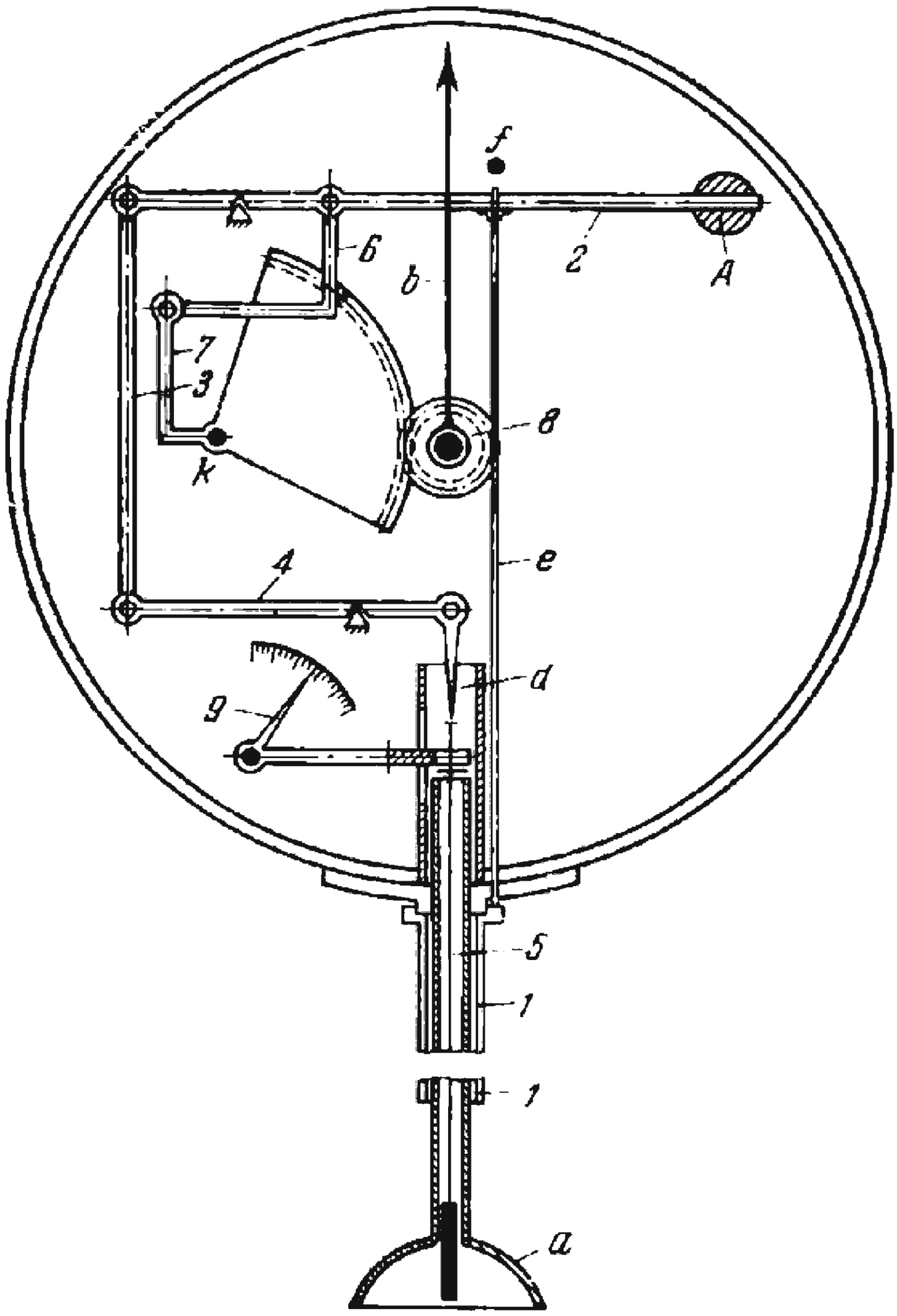
1774	GEAR-LEVER SPEED-CHANGING MECHANISM	GL SE



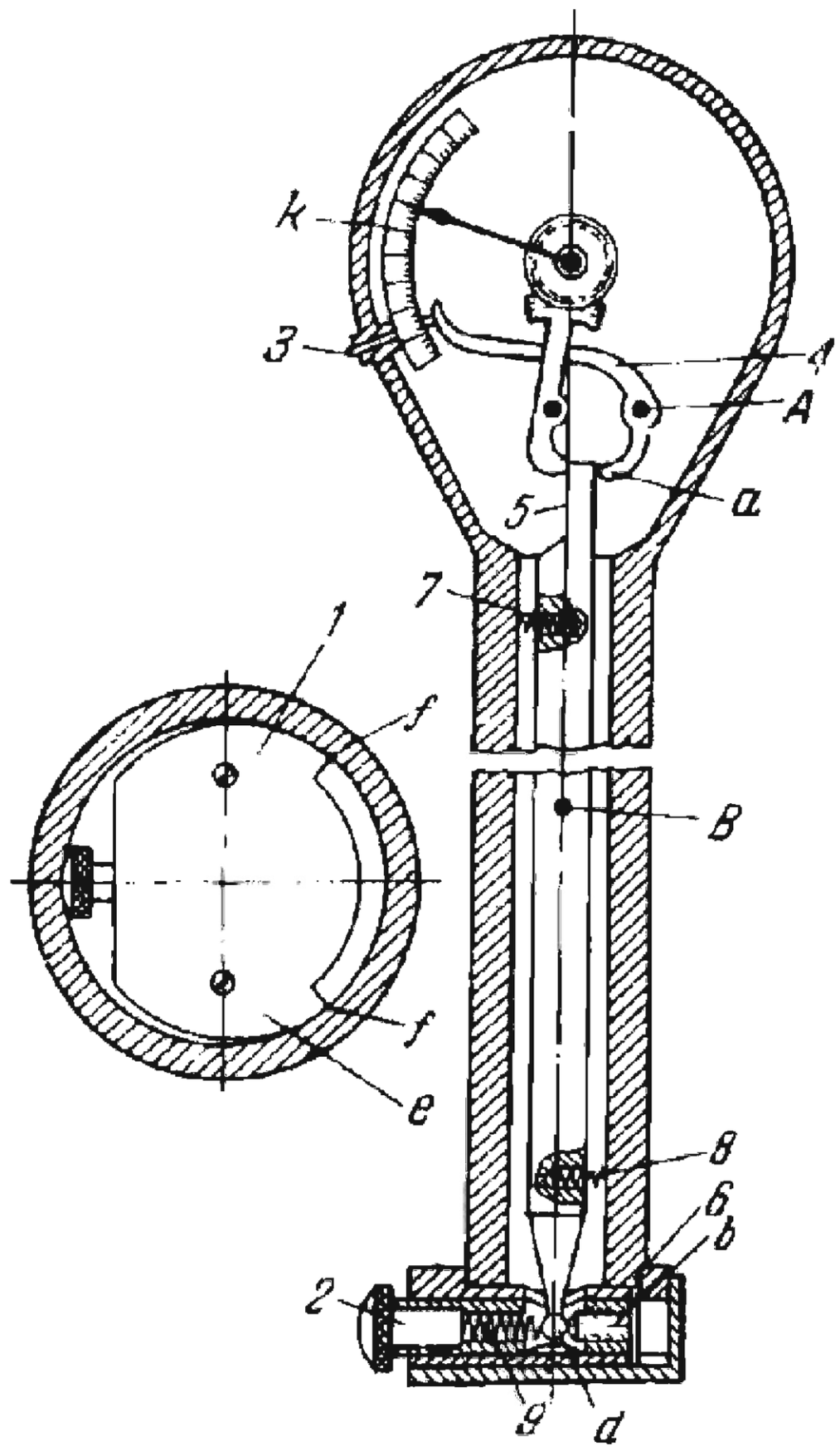
When lever *1* is turned in a horizontal plane it turns housing *2* and shaft *3*. Gear *5* is rigidly mounted on shaft *3* and fits in the internal gear of link *6*, the two gears being the members of a toothed coupling. The left-hand end of link *6* is a gear segment which meshes with gear rack *a* of slider *4*. Thus rotation of shaft *3* is transmitted through gear (coupling member) *5* and link *6* to shift slider *4*. When lever *1* is turned in a vertical plane it shifts shaft *3* vertically. This motion is converted by helical gear *8*, fitting into the internal helical gear of link *9*, into rotation of link *9*. Through the gear segment at the left-hand end of link *9* and a gear rack, displacement of shaft *3* is transmitted to shift slider *7*. In this way, when lever *1* is shifted horizontally or vertically, it shifts either slider *4* or slider *7* which changes the speeds in the feed gearbox (not shown).

14. MECHANISMS OF MEASURING AND TESTING DEVICES (1775 through 1782)

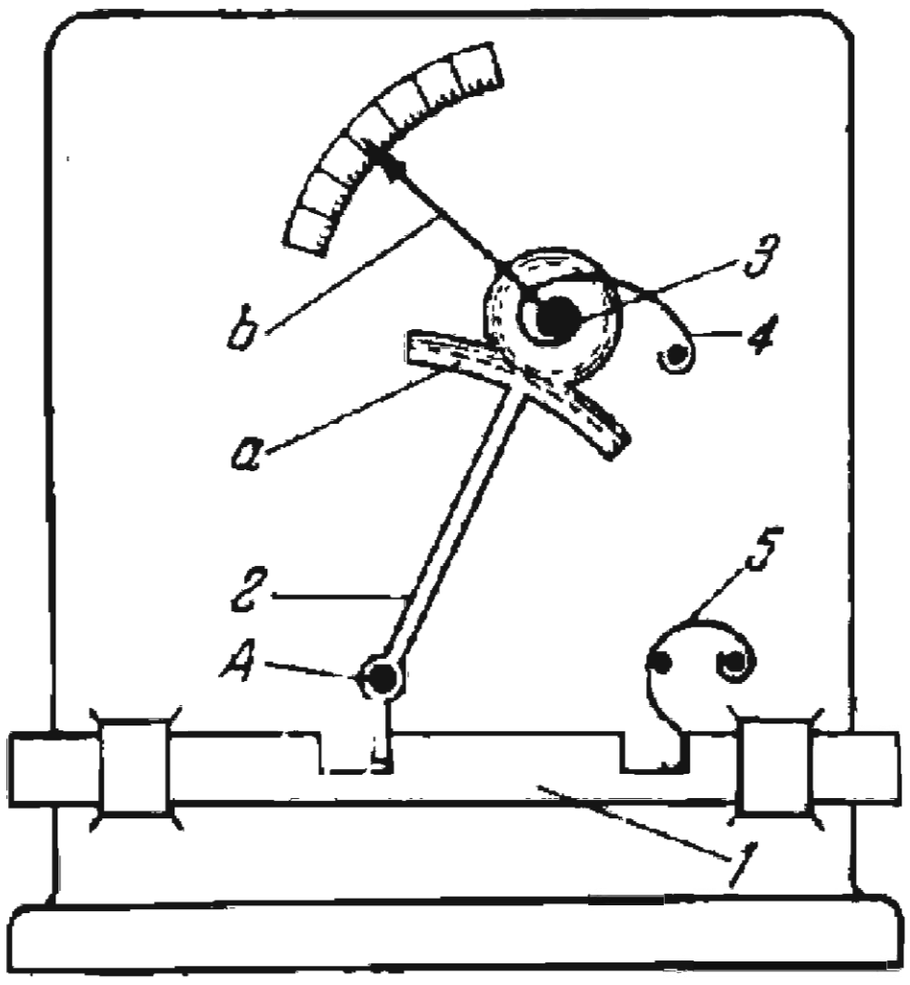
1775	SOLONINKIN GEAR-LEVER TONOMETER MECHANISM	GL M



To measure intra-ocular tension the tonometer is placed with its concave member *a* on the eyeball and sleeve *1* is gradually lowered. Lowered together with sleeve *1* are pin *e* and weight *A* of lever *2*. The motion of weight *A* is transmitted through links *2*, *3* and *4* to pin *5* which presses against the eyeball. Hand *b*, indicating the pressure on the eyeball, is actuated, when weight *A* descends, through links *2*, *6* and *7*, segment gear *k* and pinion *8*. If pin *5* is in proper contact with point *d* of link *4* when the instrument is placed on the eyeball, then check hand *9* begins to deviate together with hand *b*. If check hand *9* begins to deviate later than hand *b*, then the motion of weight *A*, indicated by hand *b*, is idle up to the instant hand *9* begins to deviate, and is not to be taken into account. Pin *f* serves to limit the amount the weight can be raised by pin *e*.



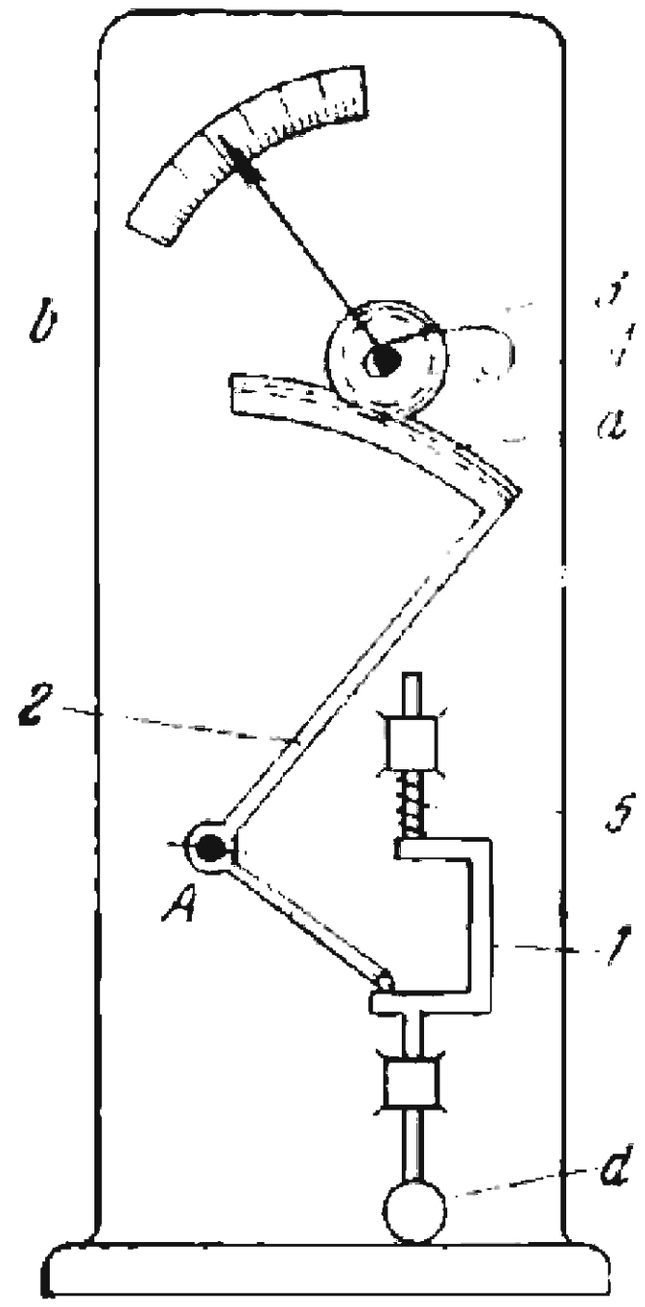
To insert gauging head *1* into the bore to be measured, sensitive contact *2* is retracted by pushing button *3* which turns lever *4* clockwise about fixed axis *A*. End *a* of lever *4*, runs up against a lug of lever *5*, turning the latter counterclockwise about fixed axis *B* so that its ball tip *d* forces screw *b* to the right, retracting sleeve *6* and sensitive contact *2*. When button *3* is released, springs *7* and *8* return lever *5* to its vertical position, and lever *5* and spring *9* advance sensitive contact *2* to the left. Screwed to gauging head *1* is plate *e* whose edge is ground spherical to a radius somewhat less than the radius of the bore to be measured. Since the part of the plate at contact *2* is cut off, the gauge will contact the bore at two points *f*, located at 120° from each other, and at the spherical tip of sensitive contact *2*. Deviations of the bore diameter from its nominal size are indicated on scale *k*.



Measuring spindle *1* actuates lever *2* which has gear segment *a* and turns about fixed axis *A*. This transmits rotation to pinion *3* with hand *b*. Spring *4* eliminates backlash in the gearing so that only one side of the teeth are in mesh.

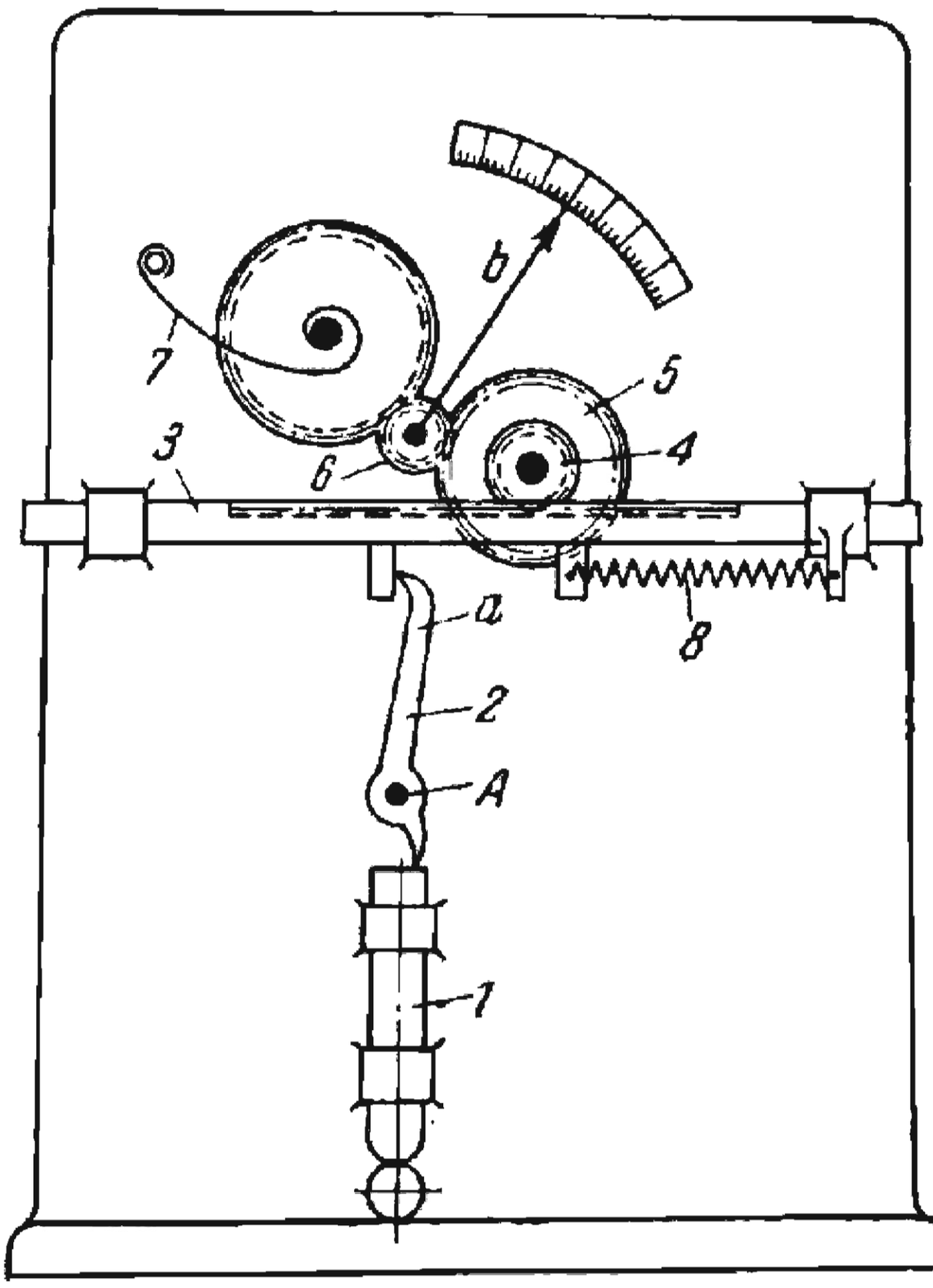
Spring *5* produces the contact pressure in measuring.

1778	GEAR-LEVER MECHANICAL COMPARATOR MECHANISM	GL M

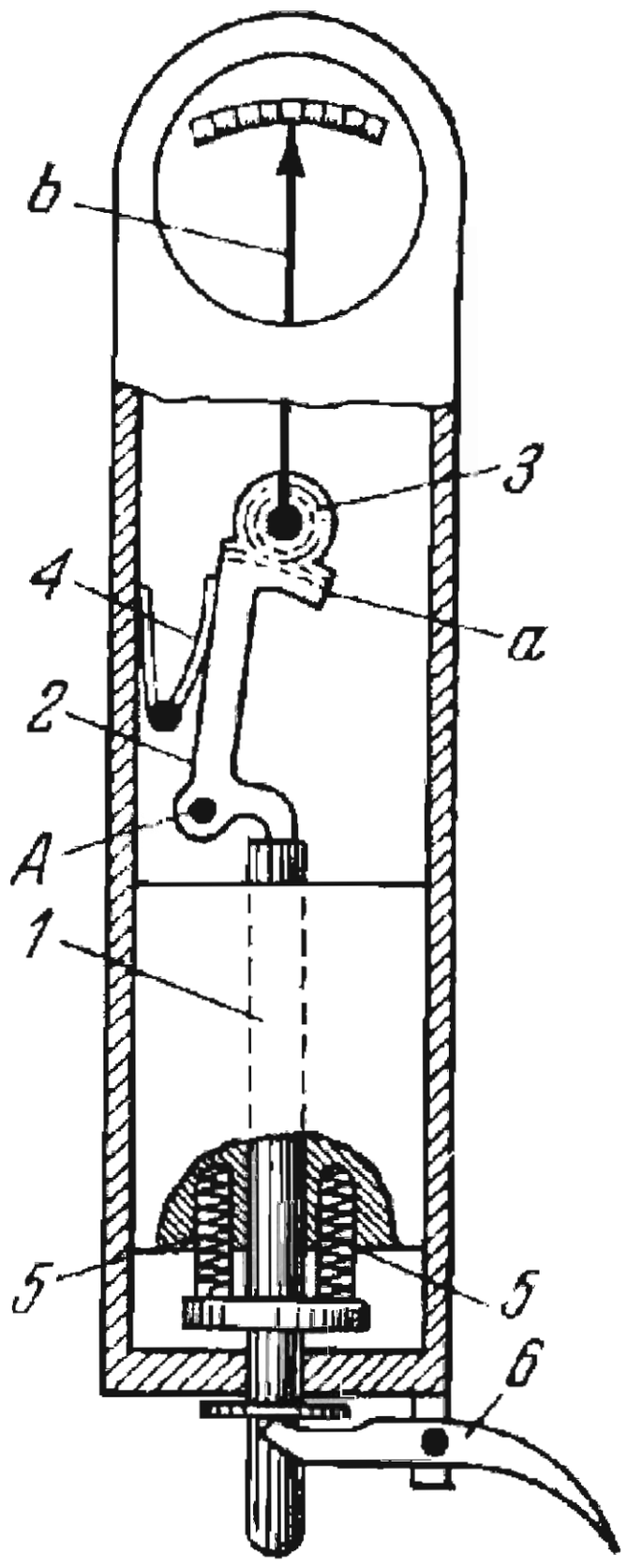


Motion is transmitted from measuring spindle *1* through lever *2* with gear segment *a*, turning about fixed axis *A*, to pinion *3* with hand *b*. Spring *4* eliminates backlash in the gearing so that only one side of the teeth are in mesh. Spring *5* holds measuring spindle *1* and the sensitive contact against workpiece *d*.

1779	GEAR-LEVER MECHANICAL COMPARATOR MECHANISM	GL M

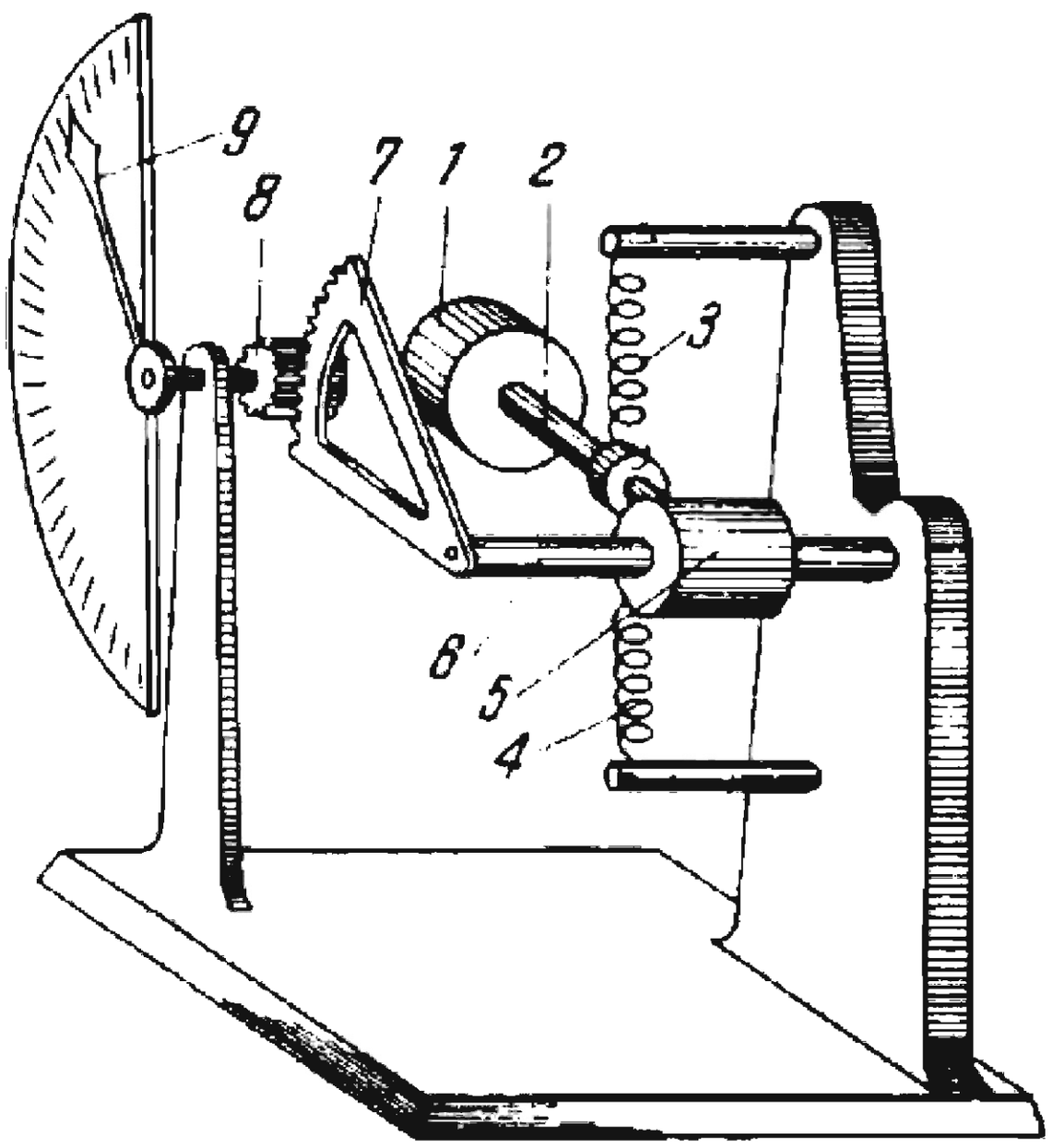


Upward motion of measuring spindle *1* turns lever *2* counterclockwise about fixed axis *A*. Tip *a* of lever *2* moves gear rack *3* to the left. This motion is transmitted by gears *4* and *5* to pinion *6* with hand *b*. Spring *7* eliminates backlash in the gearing. Spring *8* returns rack *3* to its initial position and holds rack *3*, lever *2* and spindle *1* in contact with one another. It also produces the contact pressure in measuring.

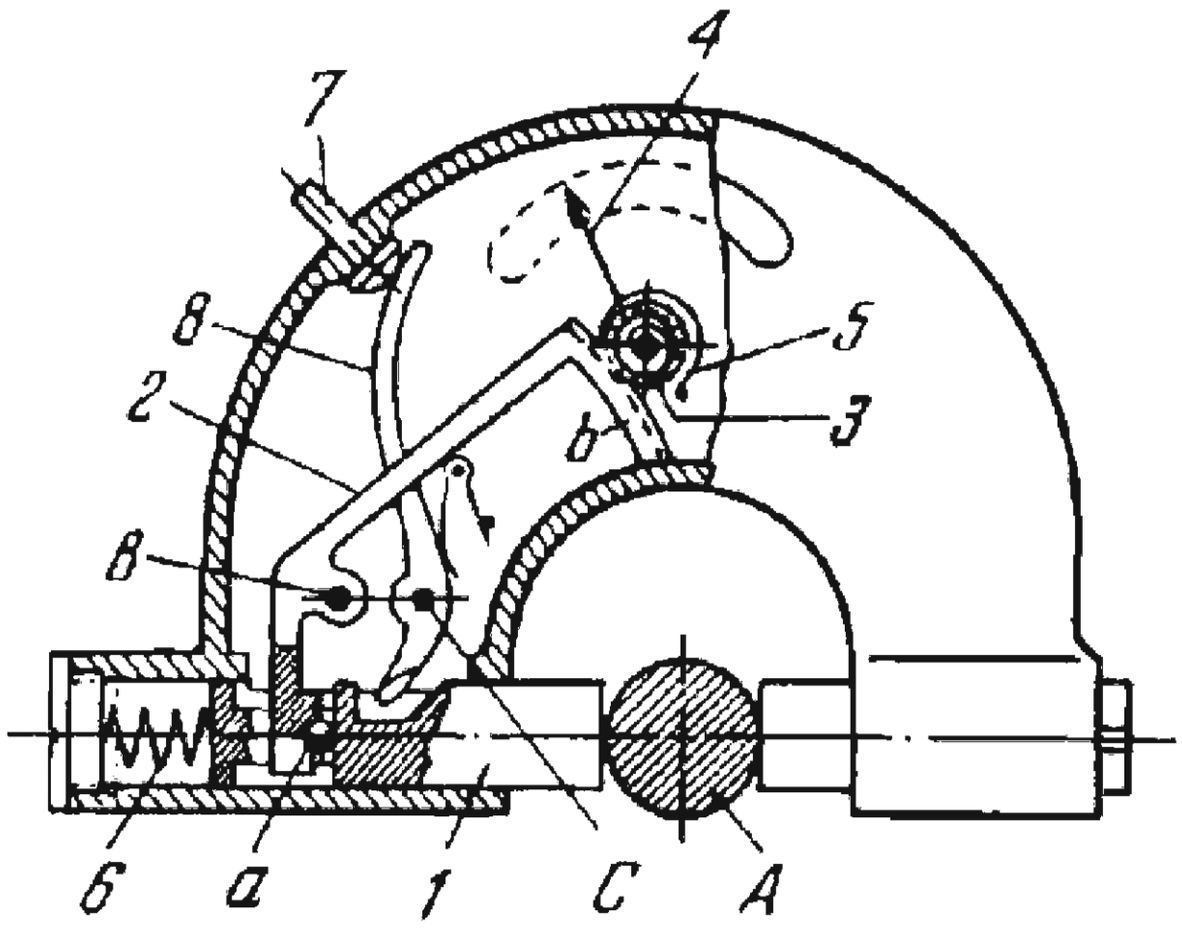


Upward motion of measuring spindle *1* turns lever *2* with gear segment *a* about fixed axis *A*. This transmits rotation to pinion *3* with hand *b*. Flat spring *4* holds lever *2* against spindle *1* and spring *5* holds the sensitive contact against the workpiece with the required pressure. Lifting lever *6* retracts spindle *1* with the sensitive contact.

1781	GEAR-LEVER AIRCRAFT ACCELEROMETER	GL M



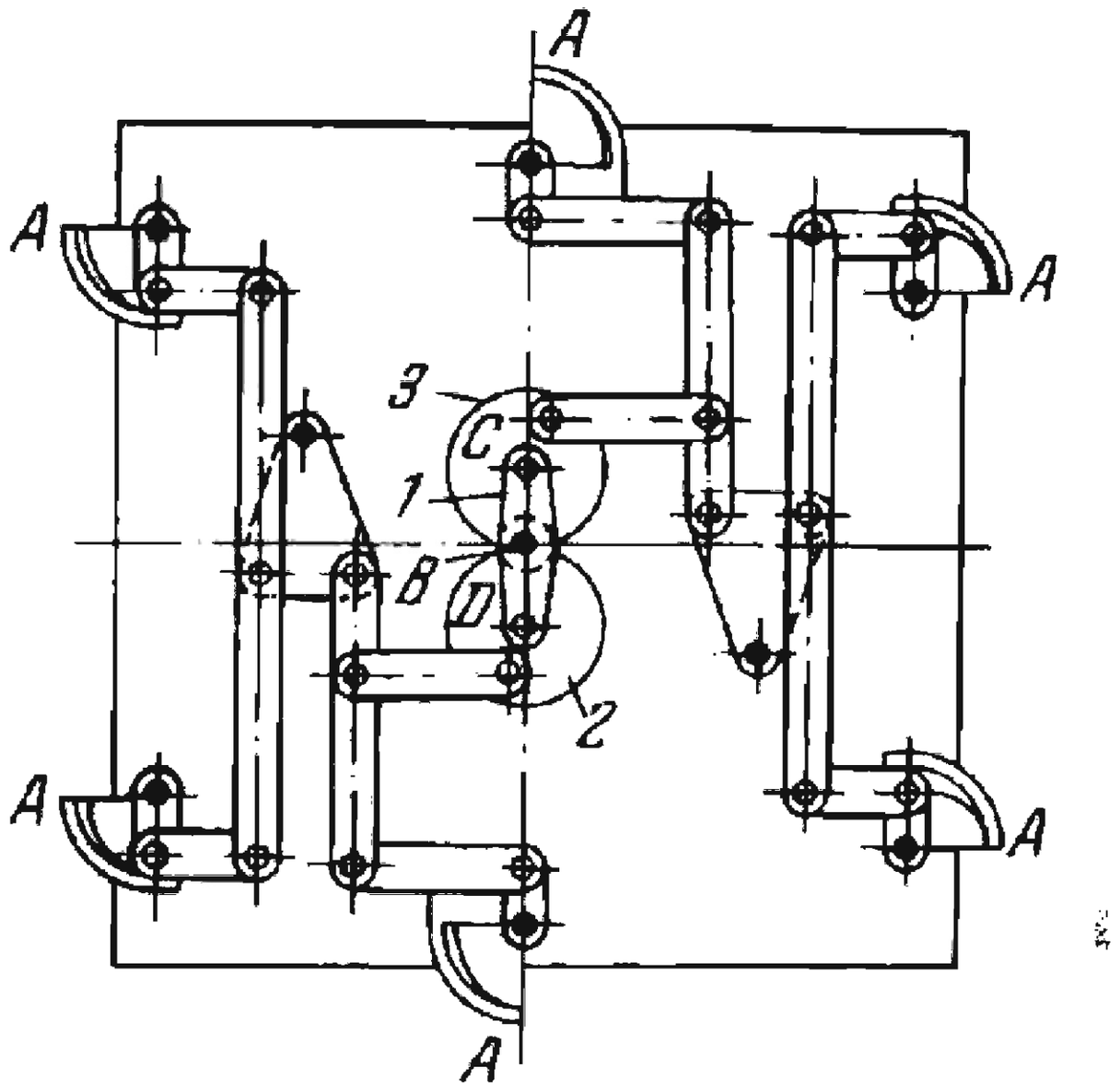
This instrument serves to determine the overload (*g*-load) in aerobatic flight of aircraft. When the plane is flying at constant velocity, weight *1* is held by springs *3* and *4* in its neutral position so that hand *9* indicates a *g*-load of unity. When the plane is executing some aerobatic maneuver, weight *1* is subject to inertia forces. Due to these forces weight *1* overcomes the resistance of spring *3* or *4* and turns lever *2* about the axis of shaft *6*. Lever *2* is connected to shaft *6* by sleeve *5*. Through gear segment *7* and pinion *8* rotation is transmitted to hand *9* which indicates the *g*-load due to the maneuver of the plane.



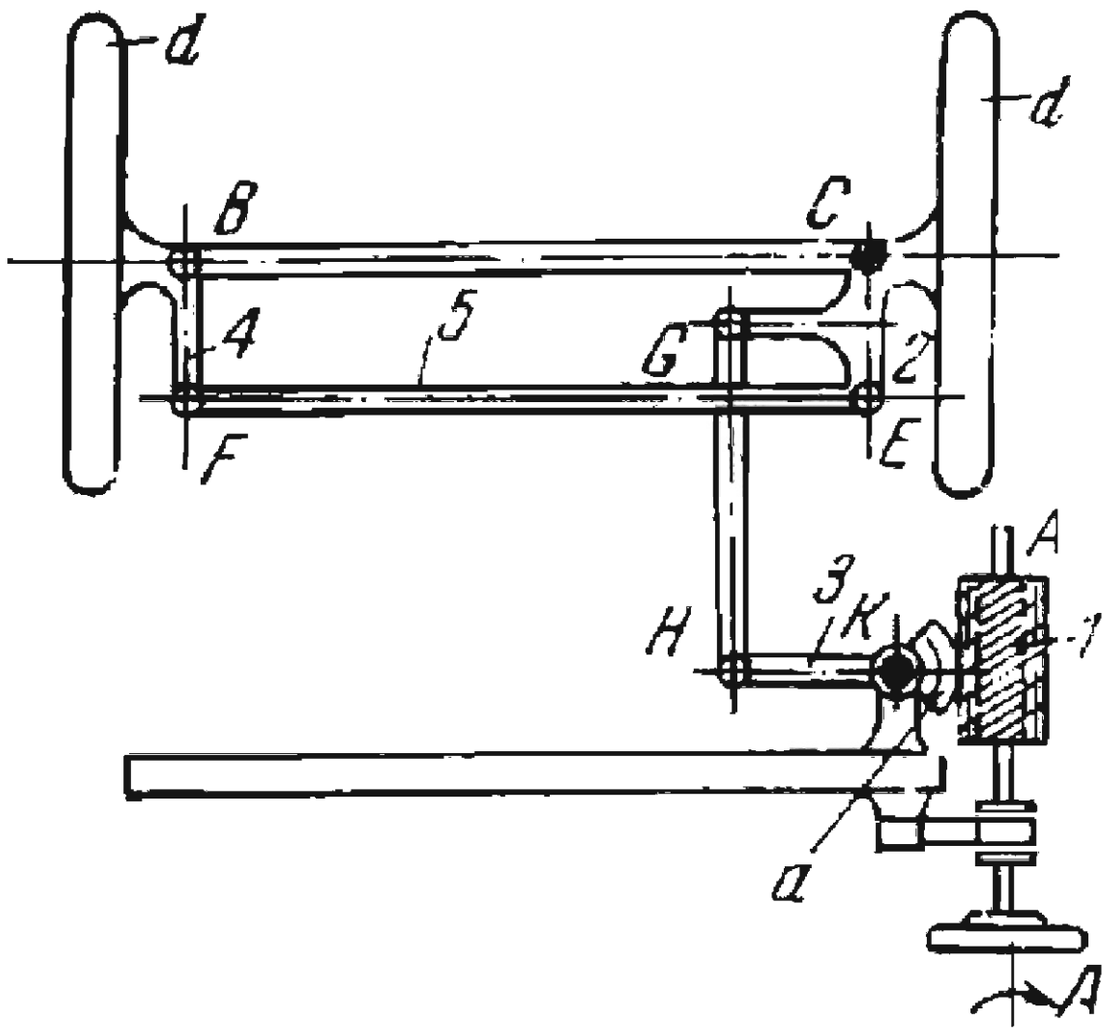
Through pin *a* measuring spindle *1* turns bent lever *2* about fixed axis *B*. This motion is transmitted by gear segment *b* of lever *2* and pinion *3* to hand *4*. Coil spring *5* eliminates backlash in the gearing and holds lever *2* against spindle *1*. Spring *6* holds spindle *1* and the sensitive contact against workpiece *A*. The sensitive contact is retracted to release workpiece *A* by pressing button *7* which turns lever *8* about fixed axis *C*. The end of lever *8* retracts spindle *1*.

15. MECHANISMS OF OTHER FUNCTIONAL DEVICES
(1783 through 1788)

1783	GEAR-LEVER REFRIGERATOR DOOR LOCK MECHANISM	GL FD

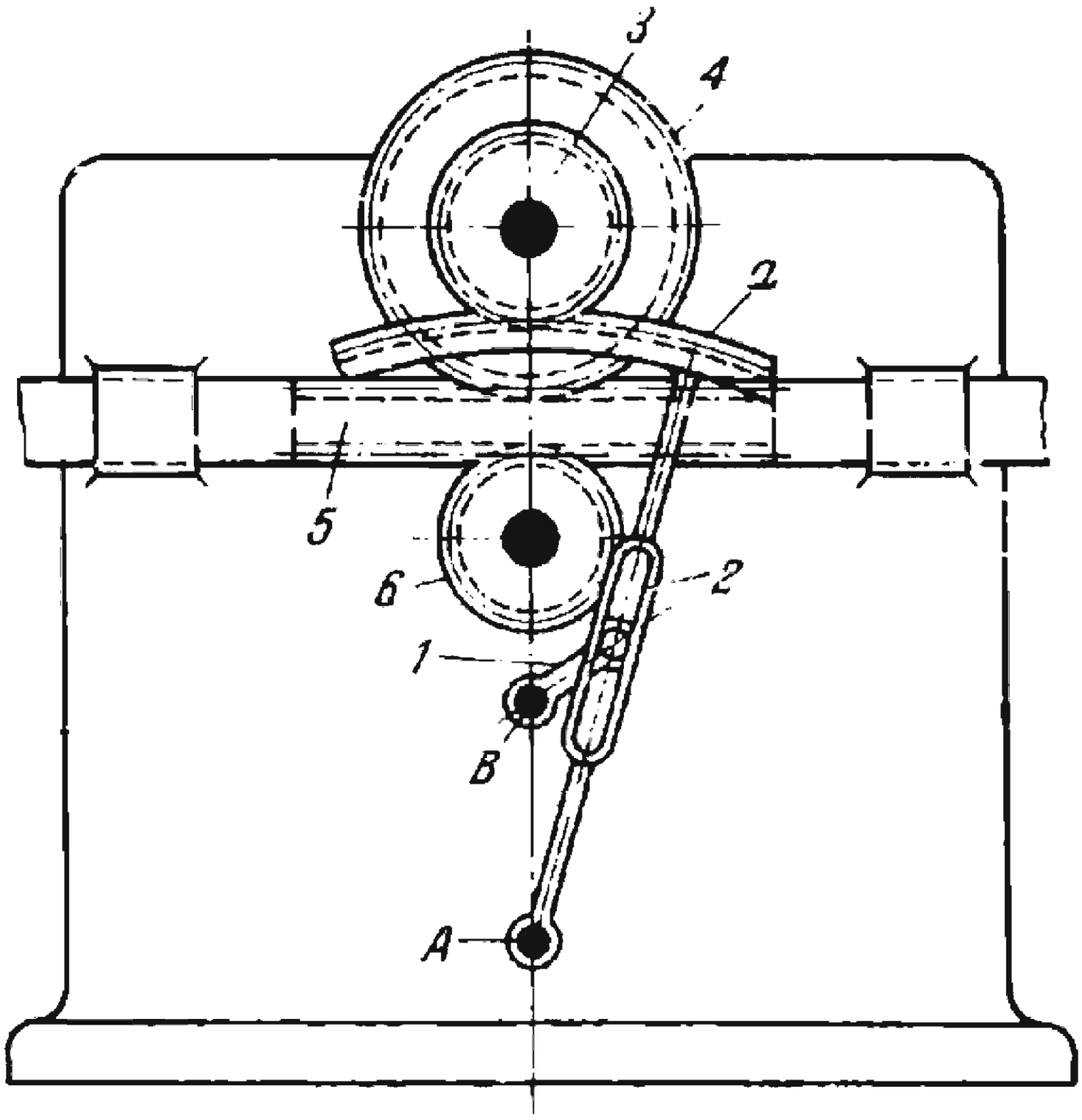


Link *1* turns about fixed axis *B* and is connected by turning pairs *C* and *D* to gears *3* and *2*. Rotary latches *A*, of segment shape, are connected to gears *2* and *3* by systems of levers. The lever system connected to gear *2* is similar to that connected to gear *3*. Therefore, when a torque is applied to link *1*, the forces acting on the lever systems transmitting motion to latches *A* are equal in magnitude and counterbalance each other. The forces of resistance applied to latches *A* also counterbalance one another. As a result, even though the mechanism has several degrees of freedom, there is certainty of motion when link *1* is turned. Latches *A* turn about their fixed axes and lock the refrigerator door.

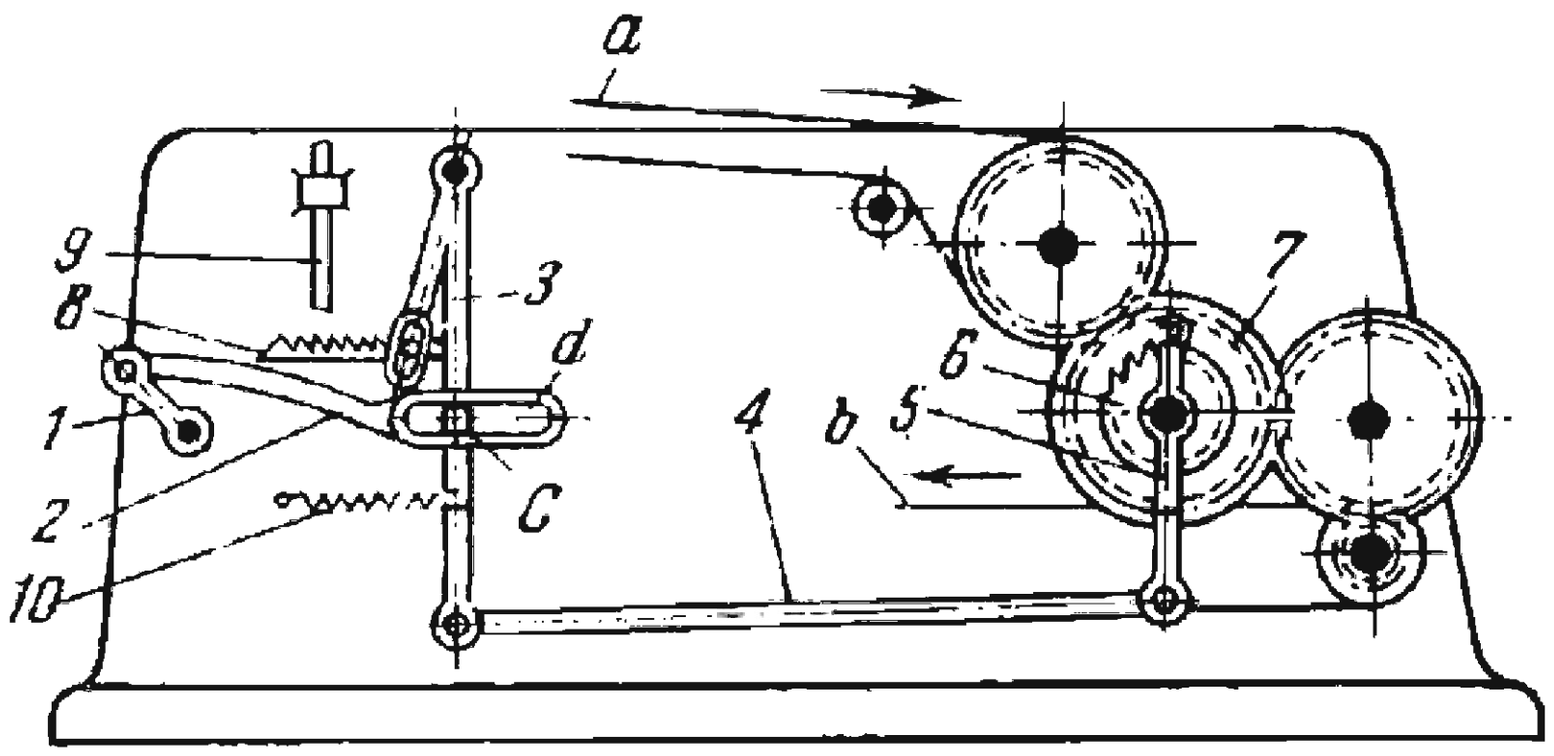


The lengths of the links comply with the conditions: $\overline{FE} = \overline{BC}$ and $\overline{BF} = \overline{CE}$. Worm *1* turns about axis *A* of the wagon frame and meshes with segment gear *a* of link *3* which is part of four-bar linkage *KHGC*. Link *5* of parallel-crank linkage *CEFB* is connected by turning pairs *E* and *F* to links *2* and *4* to which wheels *d* are rigidly attached. Wheels *d* are turned about axes *B* and *C* of the wagon frame by turning worm *1* about axis *A*.

1785	GEAR-LEVER DRIVE OF FLAT BEDS AND CYLINDERS FOR PRINTING PRESSES	GL FD

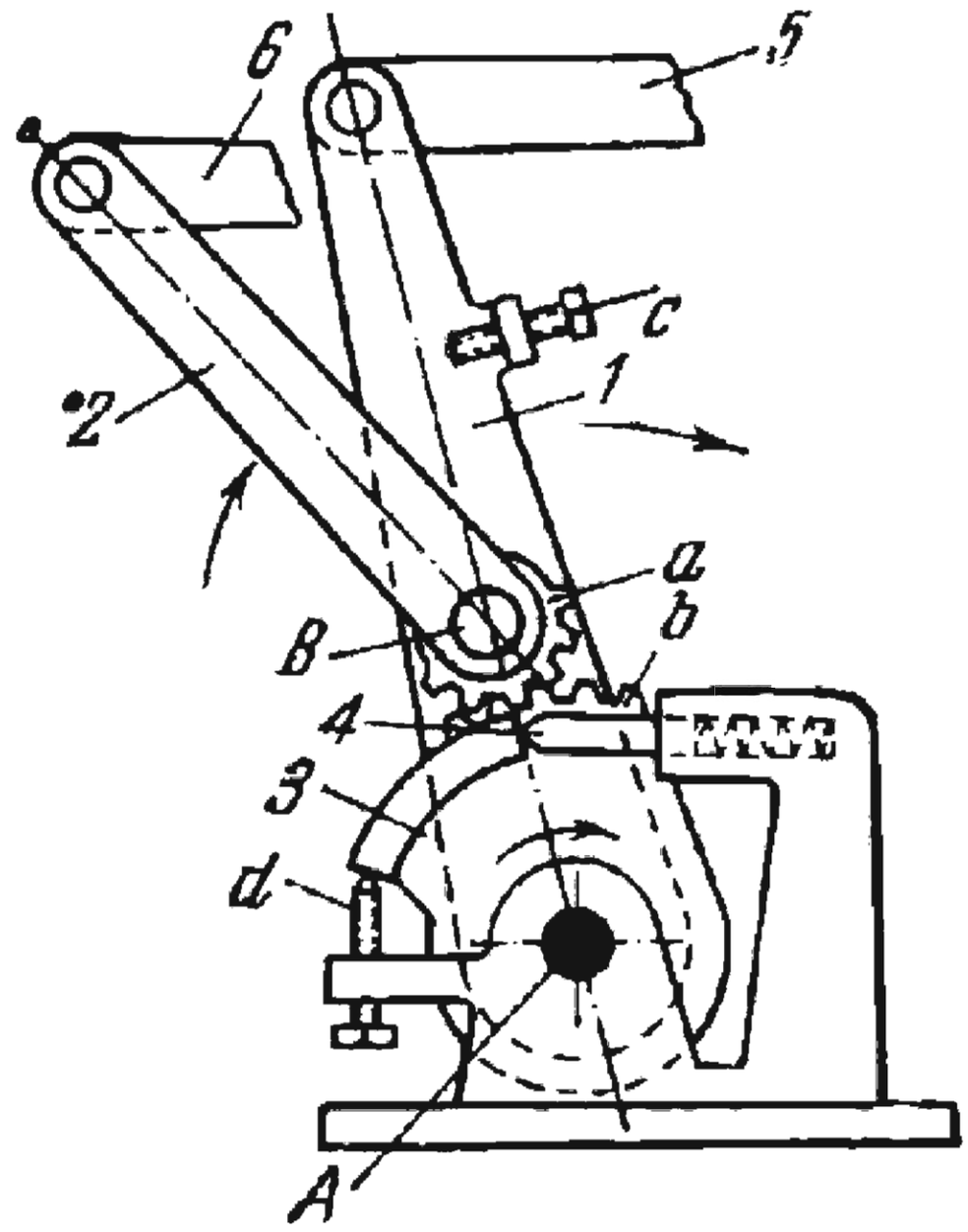


When crank *1* rotates about fixed axis *B*, slotted link *2* oscillates about fixed axis *A*. Link *2* has gear segment *a* meshing with and transmitting rotation to gear *3*. Gear *3* is mounted on the shaft of the press cylinder and is rigidly attached to gear *4* which transmits motion to flat bed *5*. Gear *6* serves as a supplementary support for the flat bed.



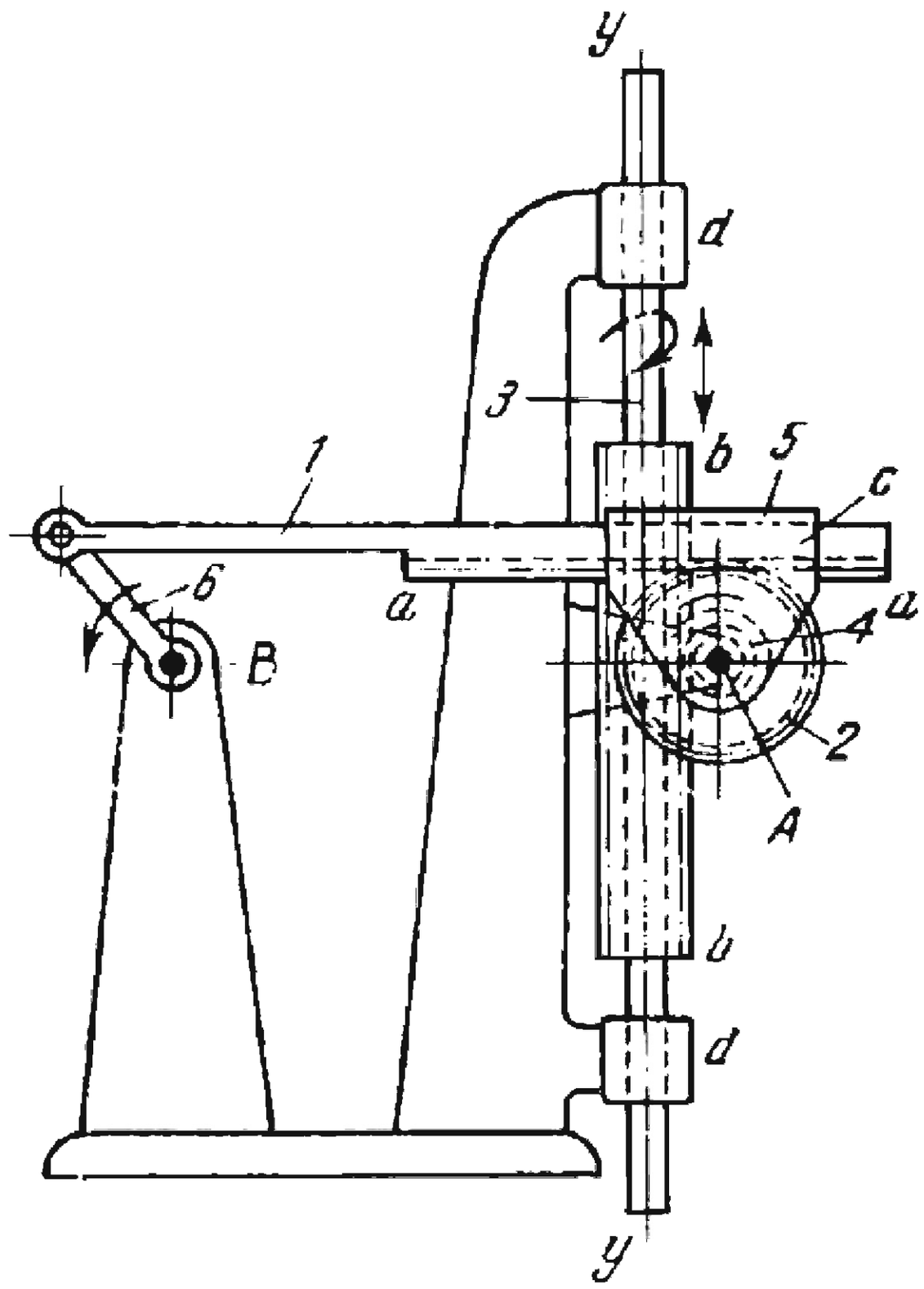
From crank *1*, mounted on the main shaft of the stacker, motion is transmitted to connecting rod *2* which has slot *d* sliding along pin *C* of link *3*. At the extreme positions of link *2*, when the ends of slot *d* run up against pin *C*, rocker arm *3* is oscillated. This motion is transmitted through tie-rod *4* and link *5* with a pawl to ratchet wheel *6*. Ratchet wheel *6* is mounted on the same shaft with gear *7* to which it is rigidly attached. From gear *7* motion is transmitted to upper conveyer *a* and to lower conveyer *b*. Connected to rocker arm *3* is ratchet-tooth rack *8* whose movement to the left can be stopped by latch *9*. This latch is operated by the lowering of the friction rolls (not shown) when paper feed must be stopped. Spring *10* provides the return stroke of rocker arm *3*.

GEAR-LEVER MECHANISM WITH VARIABLE ROD STROKES



When lever *1* turns clockwise about fixed axis *A*, plunger *4* prevents rotation of disk *3* which is mounted freely with respect to axis *A*. As a result, lever *2*, carrying segment gear *a* which meshes with gear segment *b* on disk *3*, turns clockwise about axis *B* on lever *1* until it runs against screw *c*. From this moment, levers *1* and *2* turn together to the end of their strokes, forcing back plunger *4*. When lever *1* is turned counterclockwise, levers *1* and *2* turn together until disk *3* runs against screw *d* mounted on the base. At further motion of lever *1*, lever *2*, meshing with gear segment *b*, returns to its initial position. Thus, in oscillation of lever *1*, rods *5* and *6* have different strokes, but they move synchronously over a portion of their strokes.

1788	GEAR-LEVER MECHANISM OF A GEAR SHAPER	GL FD



Link *1* has gear rack *a-a* which meshes with gear *2* rotating about fixed axis *A*. Rigidly attached to gear *2* is helical gear *4* which meshes with helical rack *b-b* of link *3*. Rack *a-a* slides in guide *c* of link *5* which turns about axis *A*. When crank *6* rotates about fixed axis *B*, gear *4* is oscillated about axis *A* and link *3* reciprocates in guides *d-d*. Besides, link *3* can be rotated about axis *y-y* from an independent drive.

SECTION EIGHT

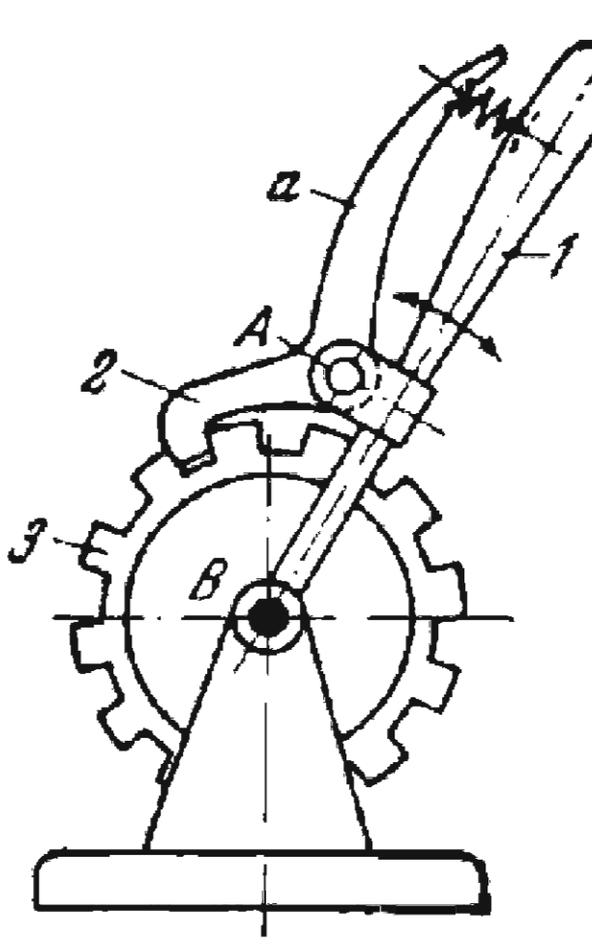
Lever-Ratchet Mechanisms

LR

1. General-Purpose Four-Link Mechanisms 4L (1789 through 1802)
2. General-Purpose Five-Link Mechanisms 5L (1803 through 1806)
3. General-Purpose Six-Link Mechanisms 6L (1807 through 1818)
4. General-Purpose Multiple-Link Mechanisms ML (1819 through 1834)
5. Dwell Mechanisms D (1835)
6. Switching, Engaging and Disengaging Mechanisms SE (1836, 1837 and 1838)
7. Stop, Detent and Locking Mechanisms SD (1839, 1840 and 1841)
8. Mechanisms of Materials Handling Equipment MH (1842)
9. Sorting and Feeding Mechanisms SF (1843 and 1844)
10. Mechanisms of Measuring and Testing Devices M (1845)
11. Mechanisms of Other Functional Devices FD (1846 through 1856)

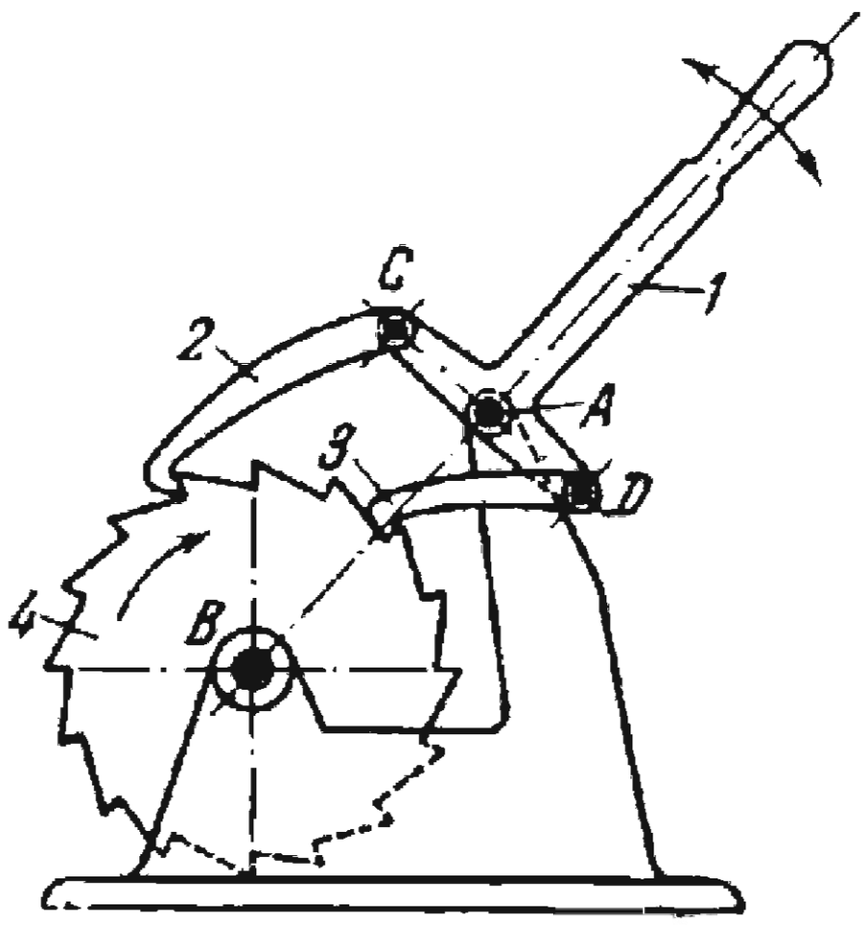
1. GENERAL-PURPOSE FOUR-LINK MECHANISMS
(1789 through 1802)

1789	LEVER-RATCHET MECHANISM	LR 4L



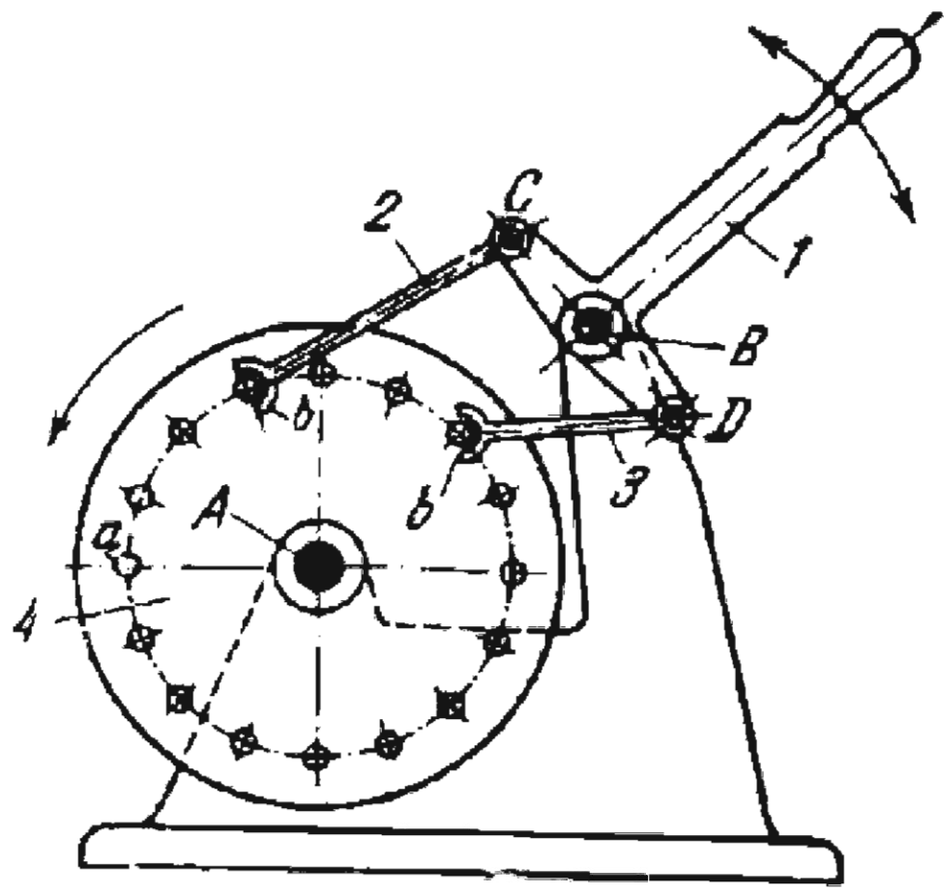
Pawl *2* turns about axis *A* on lever *1*. Ratchet wheel *3* rotates independently of lever *1* about fixed axis *B*. When lever *1* is turned about axis *B*, pawl *2* engages the teeth of and turns ratchet wheel *3*. The pawl is disengaged by turning handle *a* about axis *A* toward lever *1*.

1790	LEVER-RATCHET MECHANISM	LR 4L



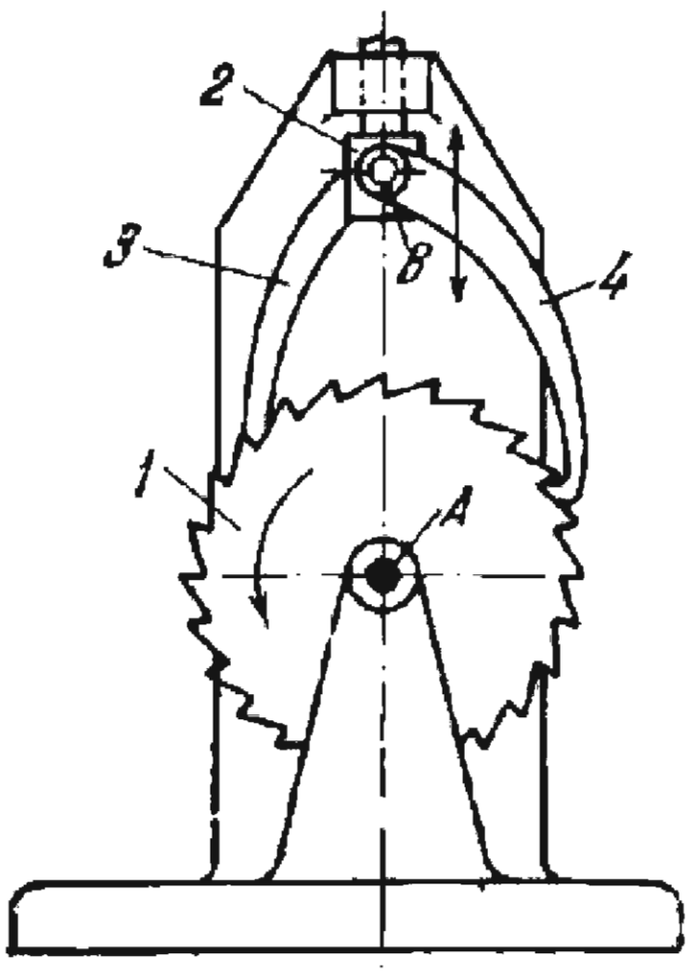
Ratchet wheel *4* rotates about fixed axis *B*. Lever *1* turns about fixed axis *A* and is connected by turning pairs *C* and *D* to pawls *2* and *3*. When lever *1* is oscillated about axis *A*, pawls *2* and *3* turn ratchet wheel *4* intermittently clockwise. Pawls *2* and *3* also serve as locks preventing reverse rotation of wheel *4*. In one complete oscillation of lever *1*, ratchet wheel *4* turns through the angle $\alpha = 720°/z$, where z is the number of teeth on wheel *4*.

1791	LEVER-RATCHET PIN-GEAR MECHANISM	LR 4L



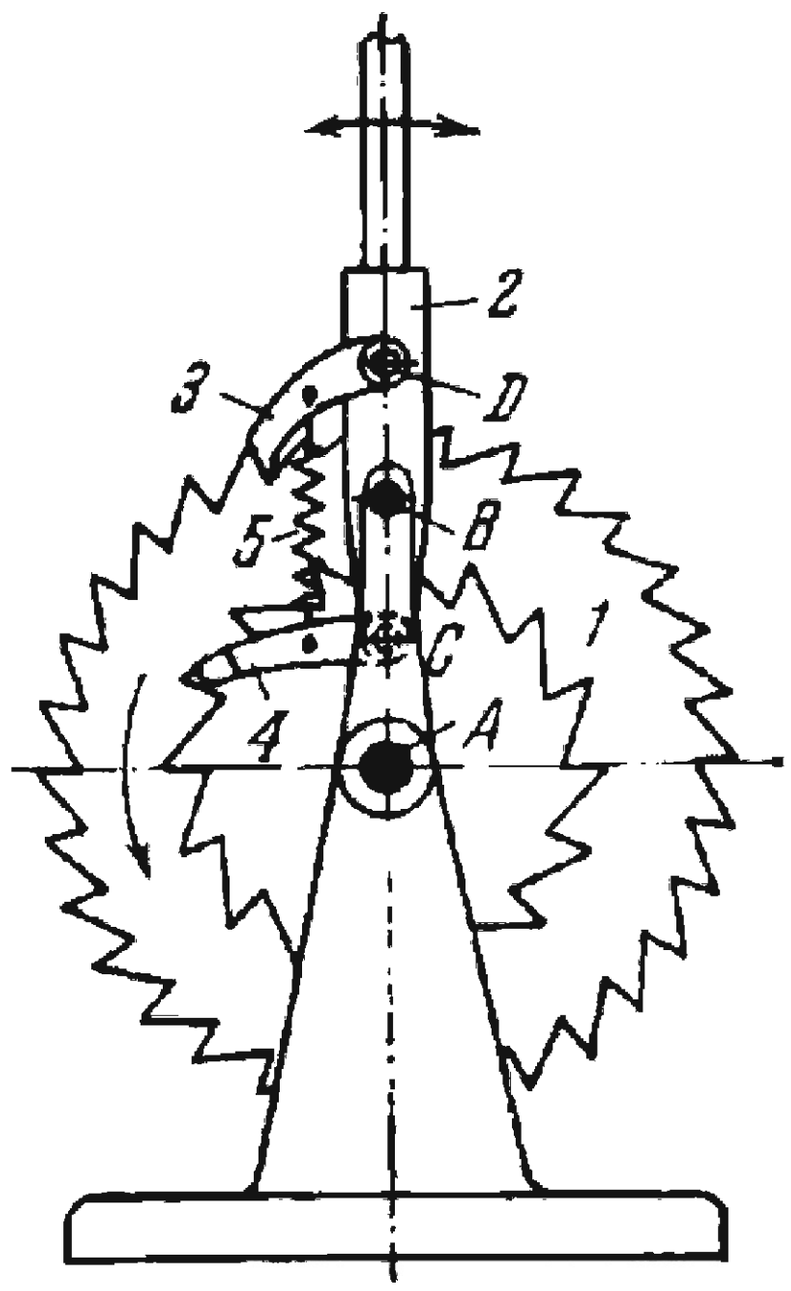
Pin-type ratchet wheel *4*, carrying pins *a*, rotates about fixed axis *A*. Lever *1* turns about fixed axis *B* and is connected by turning pairs *C* and *D* to pawls *2* and *3* which have circular members *b* at their ends. When lever *1* is oscillated about axis *B*, pawls *2* and *3* turn ratchet wheel *4* intermittently counterclockwise. Pawls *2* and *3* also serve as locks preventing reverse rotation of wheel *4*. In one complete oscillation of lever *1*, wheel *4* turns through the angle $\alpha = 720°/z$, where z is the number of pins on wheel *4*.

1792	LEVER-RATCHET MECHANISM	LR 4L



Ratchet wheel *1* turns about fixed axis *A*. Pawls *3* and *4* turn about axis *B* which is mounted on slider *2*. When slider *2* reciprocates vertically, pawls *3* and *4* alternately engage the teeth of ratchet wheel *1*, thereby turning it intermittently counterclockwise. Pawls *3* and *4* also serve as locks preventing reverse rotation of wheel *1*. In one complete stroke (up and down) of slider *2*, wheel *1* turns through the angle $\alpha = 720°/z$, where z is the number of teeth on wheel *1*.

1793	LEVER-RATCHET MECHANISM WITH EXTERNAL AND INTERNAL ENGAGEMENT	LR 4L



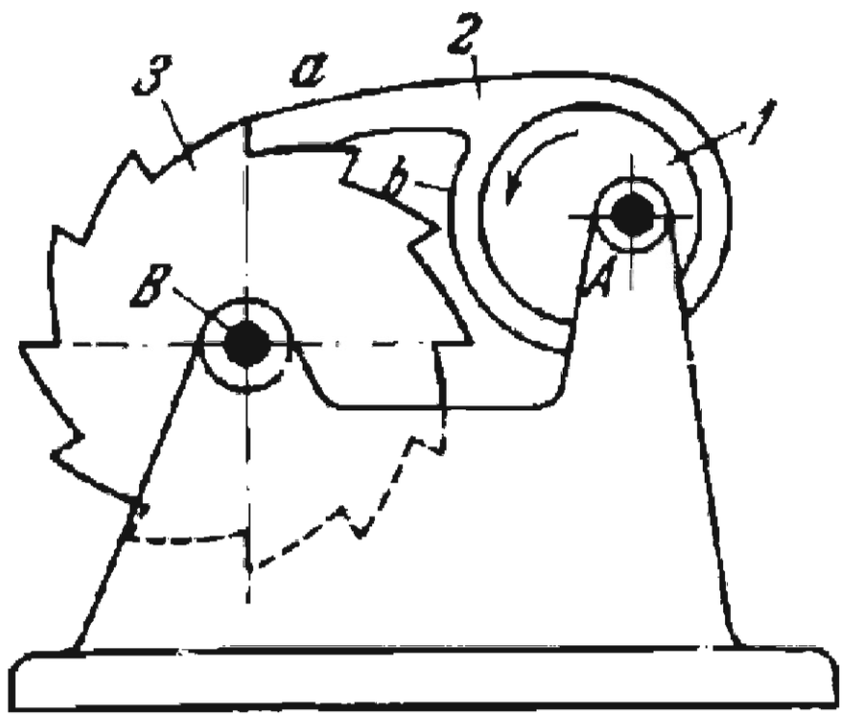
Ratchet wheel *1*, rotating about fixed axis *A*, has ratchet teeth on both external and internal surfaces of the wheel. Lever *2* turns about fixed axis *B*. Connected by turning pairs *D* and *C* to lever *2* are pawls *3* and *4* which, when lever *2* is oscillated about axis *B*, alternately engage external and internal teeth of ratchet wheel *1*, thereby turning it intermittently counterclockwise. To ensure proper engagement of pawls *3* and *4* with the teeth of wheel *1*, the pawls are connected together by spring *5*. Pawls *3* and *4* also serve as locks preventing reverse rotation of wheel *1*. In one complete oscillation (back and forth) of lever *2*, ratchet wheel *1* is turned through the angle

$$\alpha = \frac{360^\circ}{z_1} + \frac{360^\circ}{z_2}$$

where z_1 = number of external teeth on wheel *1*
z_2 = number of internal teeth on wheel *1*.

1794 ECCENTRIC-TYPE LEVER-RATCHET MECHANISM

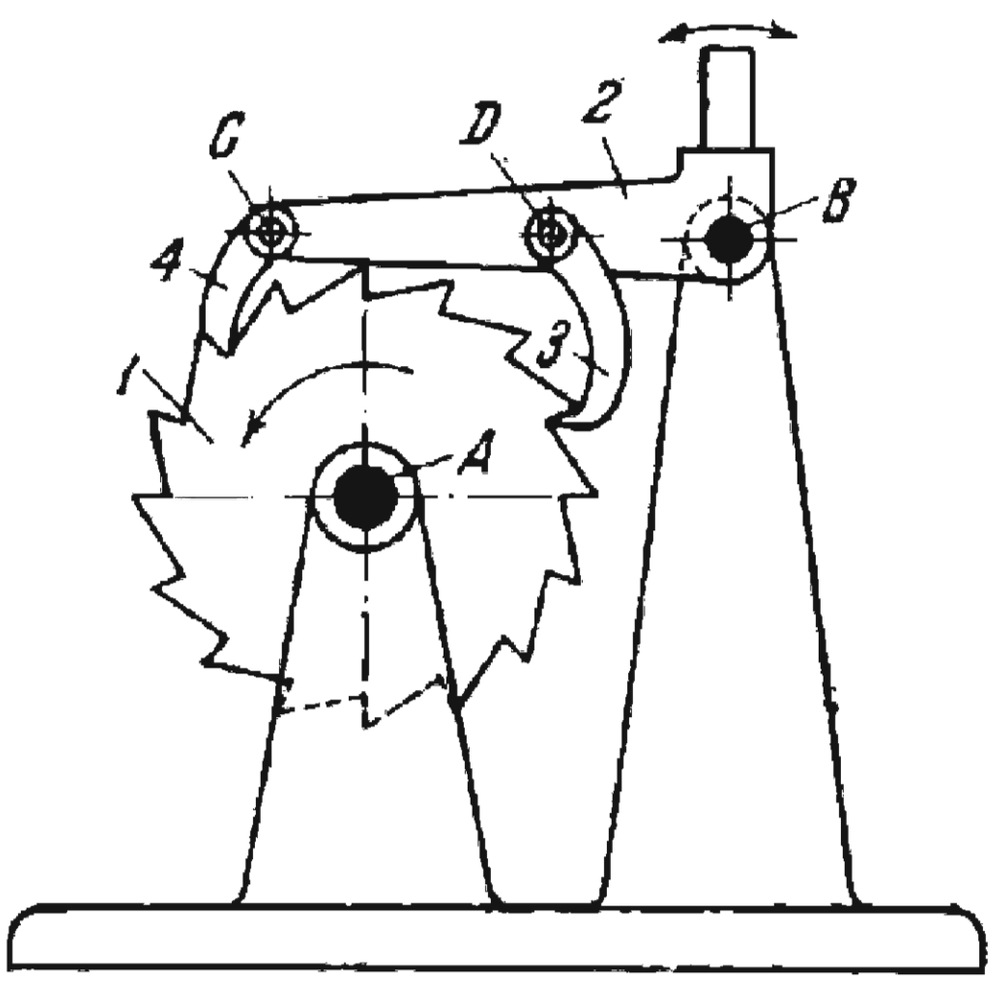
LR
4L



Eccentric *1* rotates about fixed axis *A*. Pawl *2* has collar *b* encircling round eccentric *1*. Ratchet wheel *3* rotates about fixed axis *B*. When eccentric *1* rotates counterclockwise, tip *a* of pawl *2* turns ratchet wheel *3* intermittently in the same direction. In one complete revolution of eccentric *1*, pawl *2* turns wheel *3* through the angle $\alpha = 360°/z$, where z is the number of teeth on ratchet wheel *3*.

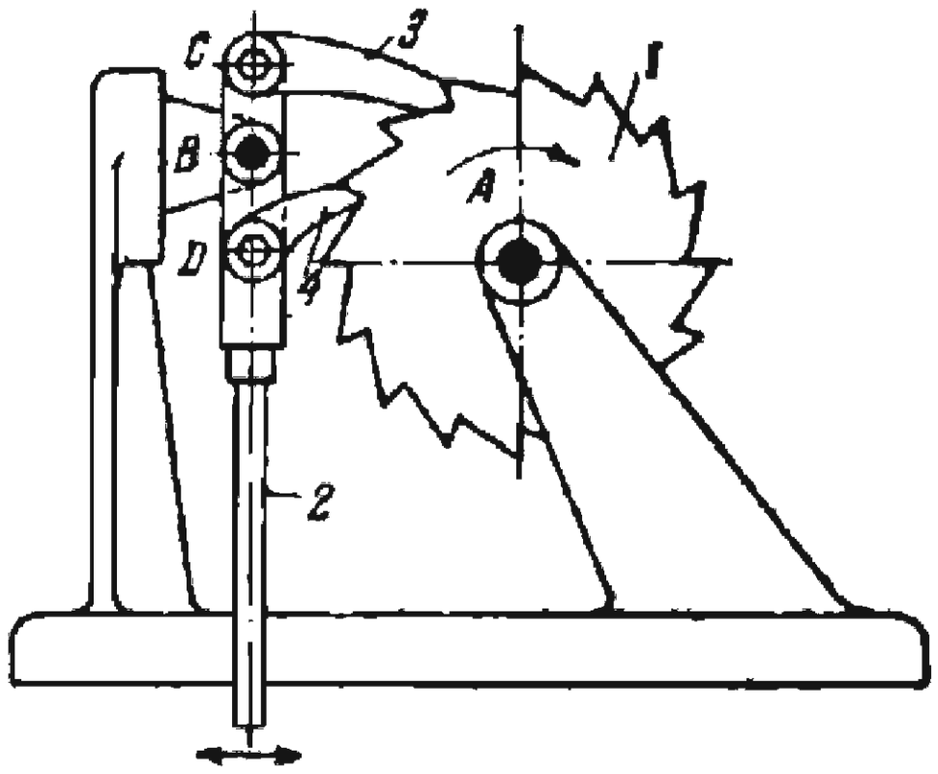
1795 LEVER-RATCHET MECHANISM

LR
4L



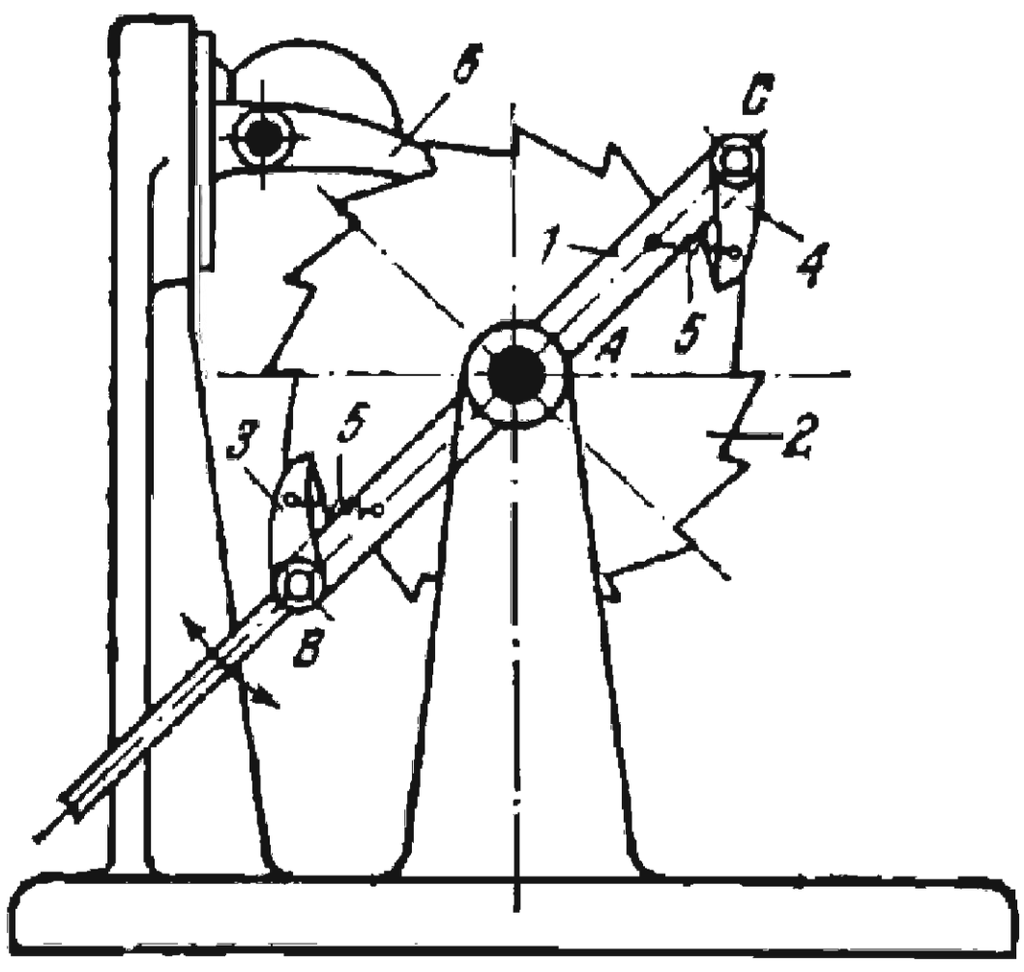
Ratchet wheel *1* rotates about fixed axis *A*. Lever *2* turns about fixed axis *B* and is connected by turning pairs *C* and *D* to pawls *4* and *3*. When lever *2* is oscillated about axis *B*, pawls *3* and *4* alternately engage the teeth of ratchet wheel *1* turning the wheel intermittently counterclockwise. Pawls *3* and *4* also serve as locks preventing reverse rotation of wheel *1*. In one complete oscillation of lever *2* (back and forth), ratchet wheel *1* turns through the angle $\alpha = 360°/z$, where z is the number of teeth on ratchet wheel *1*.

1796	LEVER-RATCHET MECHANISM	LR 4L



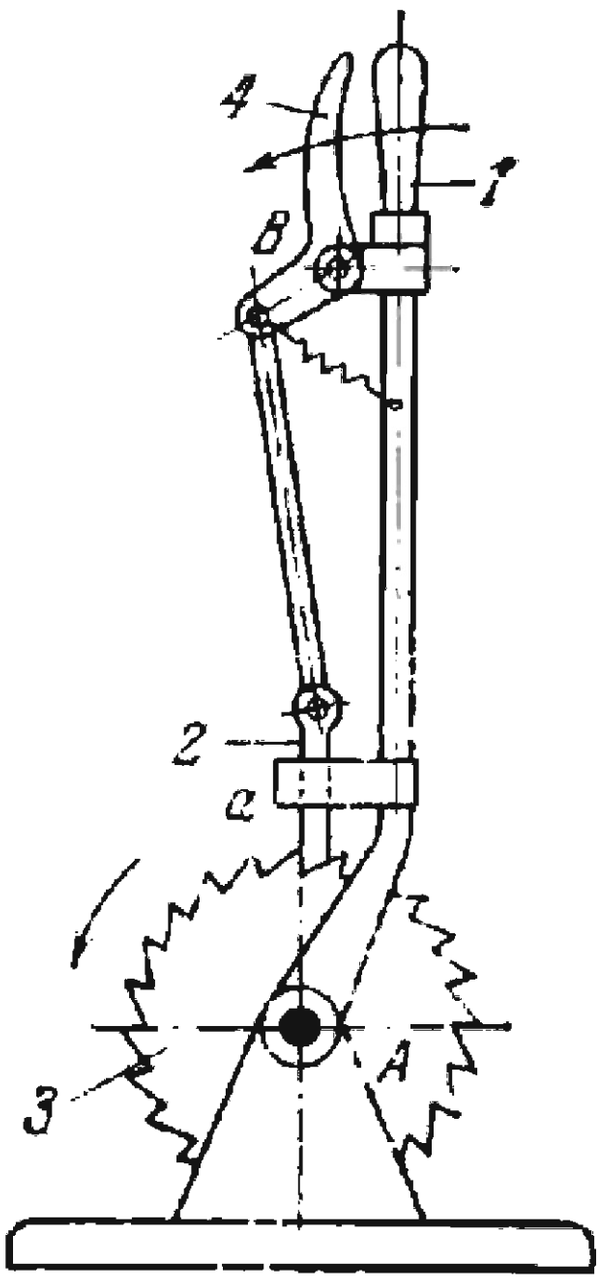
Ratchet wheel *1* rotates about fixed axis *A*. Lever *2* turns about fixed axis *B* and is connected by turning pairs *C* and *D* to pawls *3* and *4*. When lever *2* is oscillated, pawls *3* and *4* alternately engage the teeth of ratchet wheel *1*, turning the wheel intermittently clockwise. Pawls *3* and *4* also serve as locks preventing reverse rotation of wheel *1*. In one complete oscillation of lever *2* (back and forth), ratchet wheel *1* turns through the angle $\alpha = 360°/z$, where z is the number of teeth on ratchet wheel *1*.

1797	LEVER-RATCHET MECHANISM	LR 4L



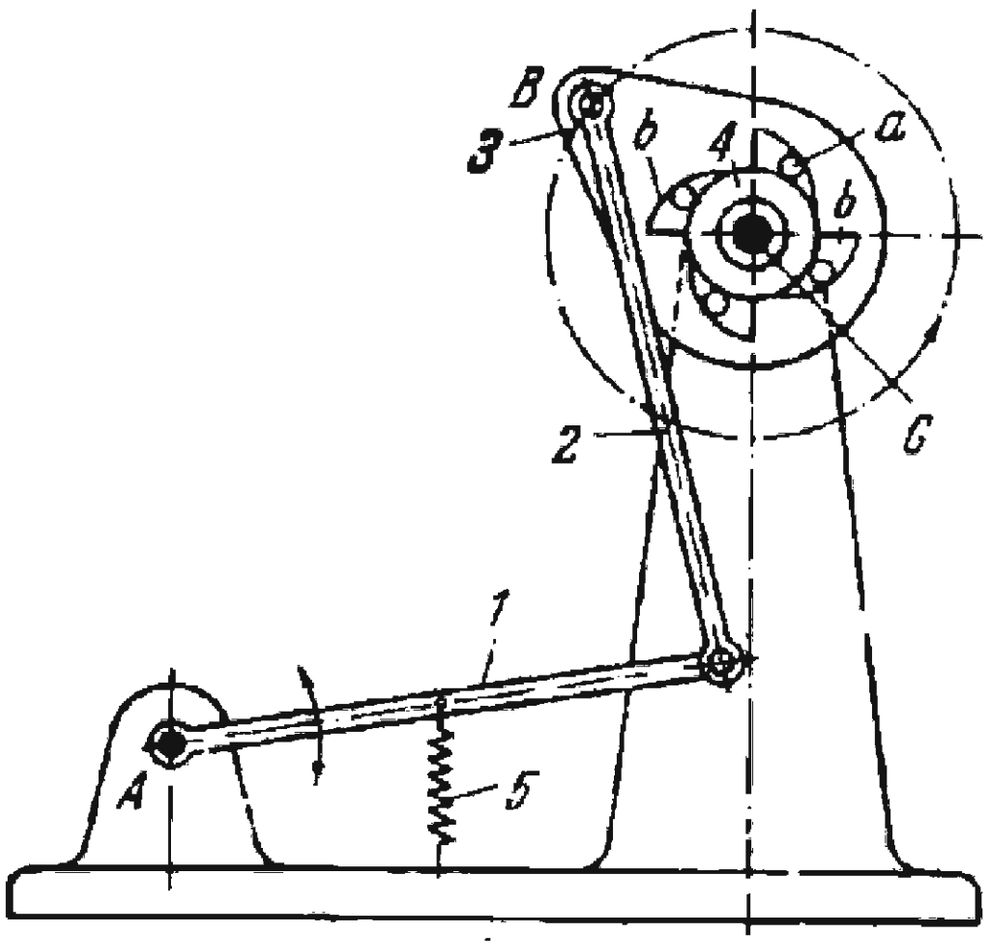
Ratchet wheel *2* and lever *1* turn independently of each other about fixed axis *A*. Lever *1* is connected by turning pairs *B* and *C* to pawls *3* and *4* which are held against ratchet wheel *2* by springs *5*. Pawl *6* locks ratchet wheel *2* against reverse rotation at the moment when pawls *3* and *4* are out of engagement with the teeth of wheel *2*.

1798	LEVER-RATCHET MECHANISM	LR 4L



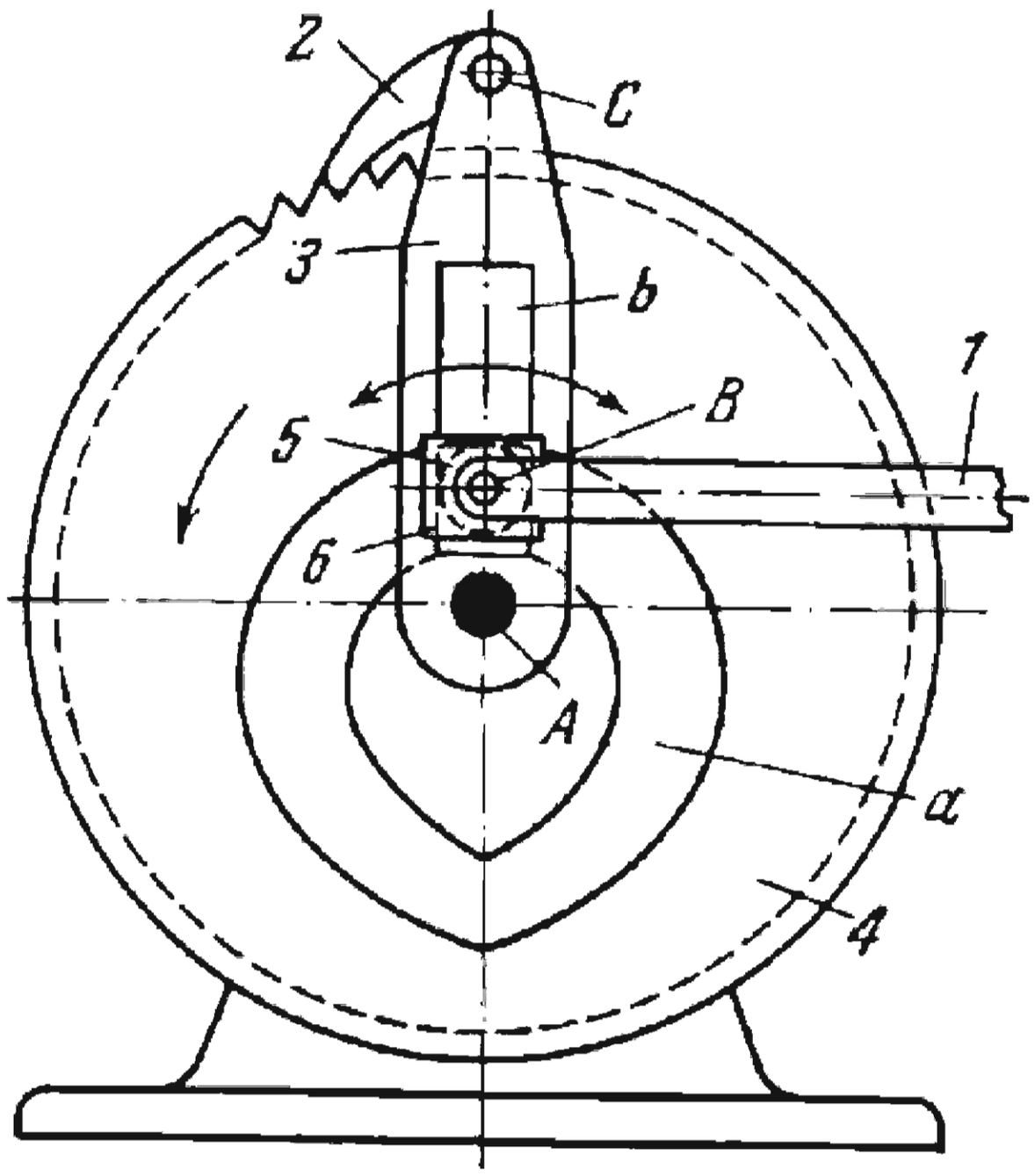
The pawl is designed as plunger *2* sliding in guide *a* which is rigidly attached to lever *1*. Ratchet wheel *3* and lever *1* turn independently of each other about fixed axis *A*. When lever *1* is turned counterclockwise about axis *A*, plunger *2* turns ratchet wheel *3* in the same direction. Plunger (pawl) *2* is disengaged from ratchet wheel *3* by turning handle *4* about axis *B* toward lever *1*.

1799	LEVER-RATCHET MECHANISM WITH ROLL-TYPE PAWLS	LR 4L



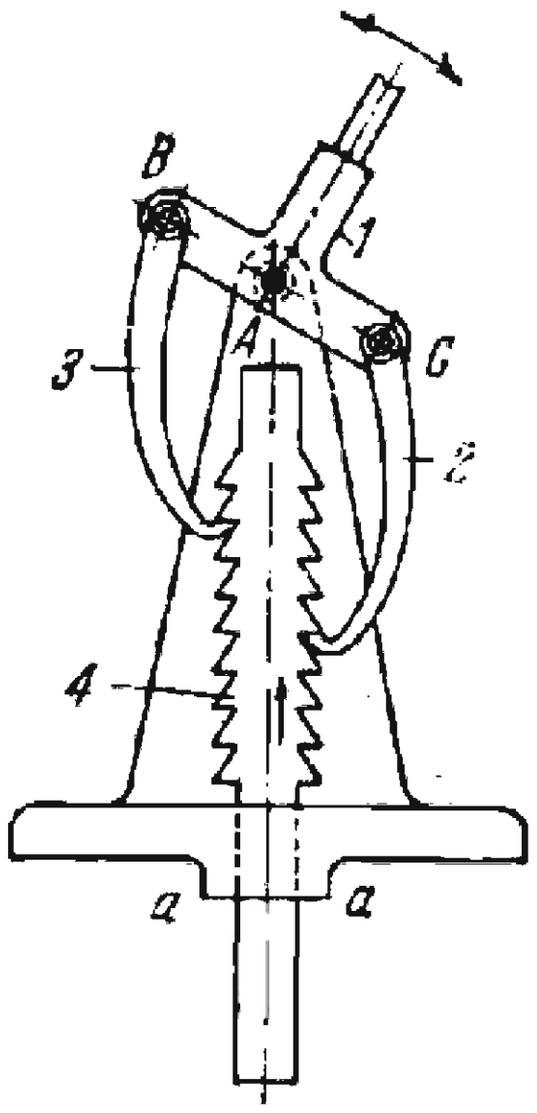
Lever *1* turns about fixed axis *A*. Connecting rod *2* is connected by turning pair *B* to link *3* which has wedge-shaped recesses *b* containing rolls *a*. Ring *4* rotates freely about fixed axis *C*. When lever *1* is oscillated about axis *A*, link *2* oscillates link *3* about axis *C*. By means of rolls *a* which become jammed in recesses *b* link *3* turns ring *4* intermittently counterclockwise. Spring *5* holds the rolls in contact with link *3* and ring *4*.

1800	LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE RATCHET WHEEL	LR 4L



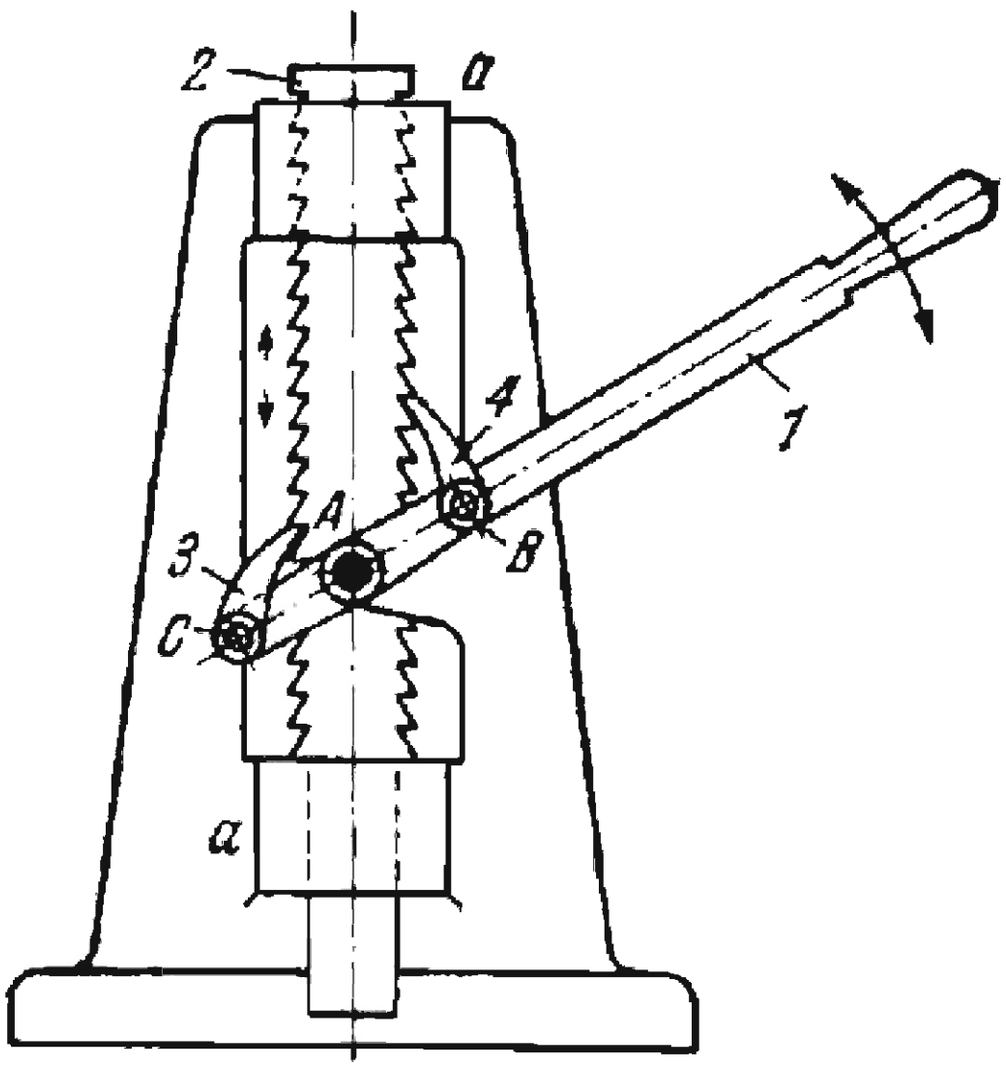
Lever *3*, turning about fixed axis *A*, is oscillated by link *1* which is connected to a drive (not shown). Link *1* is connected by turning pair *B* to slider *6* which moves along slot *b* of link *3*. Link *3* is connected by turning pair *C* to pawl *2*. When link *1* reciprocates, pawl *2* turns ratchet wheel *4* intermittently counterclockwise about axis *A*. Roll *5*, mounted on slider *6*, moves along cam groove *a* of ratchet wheel *4*. Cam groove *a* is designed of such shape that the distance between axis *A* and the centre of roll *5* gradually increases and then decreases again. This varies the angular velocity and angle of rotation of lever *3* and ratchet wheel *4*.

1801	RACK-TYPE LEVER-RATCHET MECHANISM	LR 4L



Lever *1* turns about fixed axis *A* and is connected by turning pairs *C* and *B* to pawls *2* and *3*. Ratchet-tooth rack *4* is moved intermittently in a straight line in guides *a-a* by pawls *2* and *3* which alternately engage the rack when lever *1* oscillates about axis *A*. Pawls *2* and *3* also serve as locks preventing reverse motion of rack *4*.

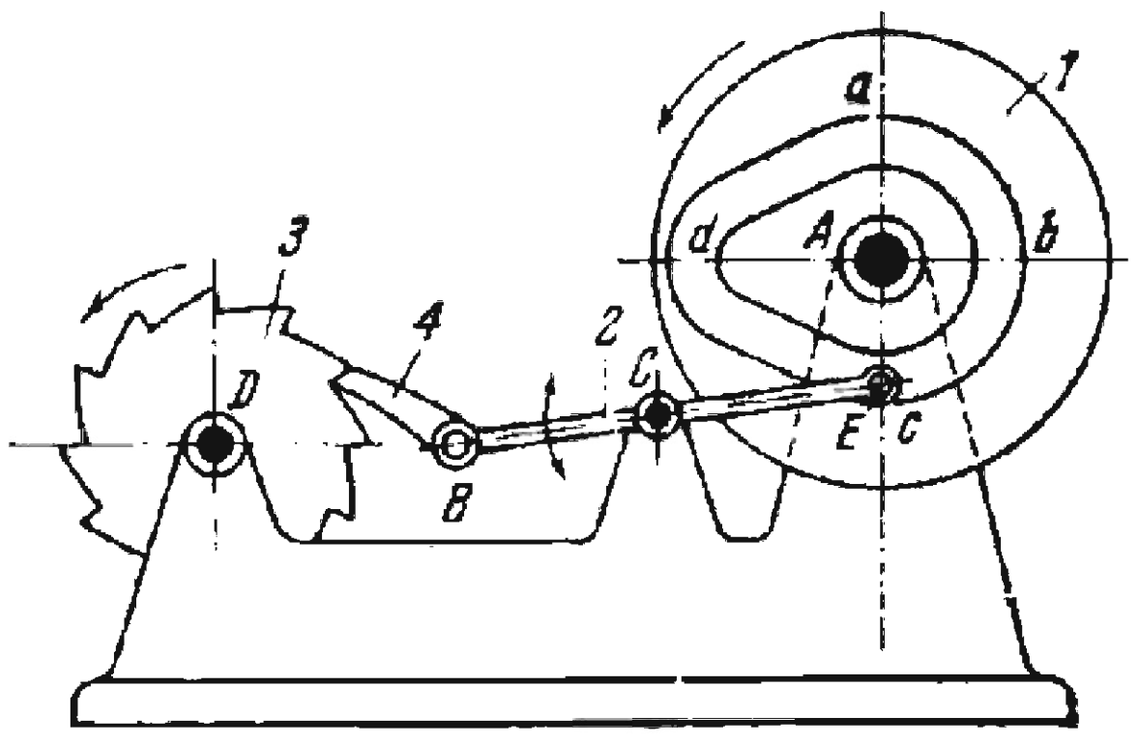
1802	RACK-TYPE LEVER-RATCHET MECHANISM	LR 4L



Lever *1* turns about fixed axis *A* and is connected by turning pairs *C* and *B* to pawls *3* and *4*. Ratchet-tooth rack *2* is moved intermittently in a straight line in guides *a-a* by pawls *3* and *4* which alternately engage the rack when lever *1* is oscillated about axis *A*. Pawls *3* and *4* also serve as locks preventing reverse motion of rack *2*.

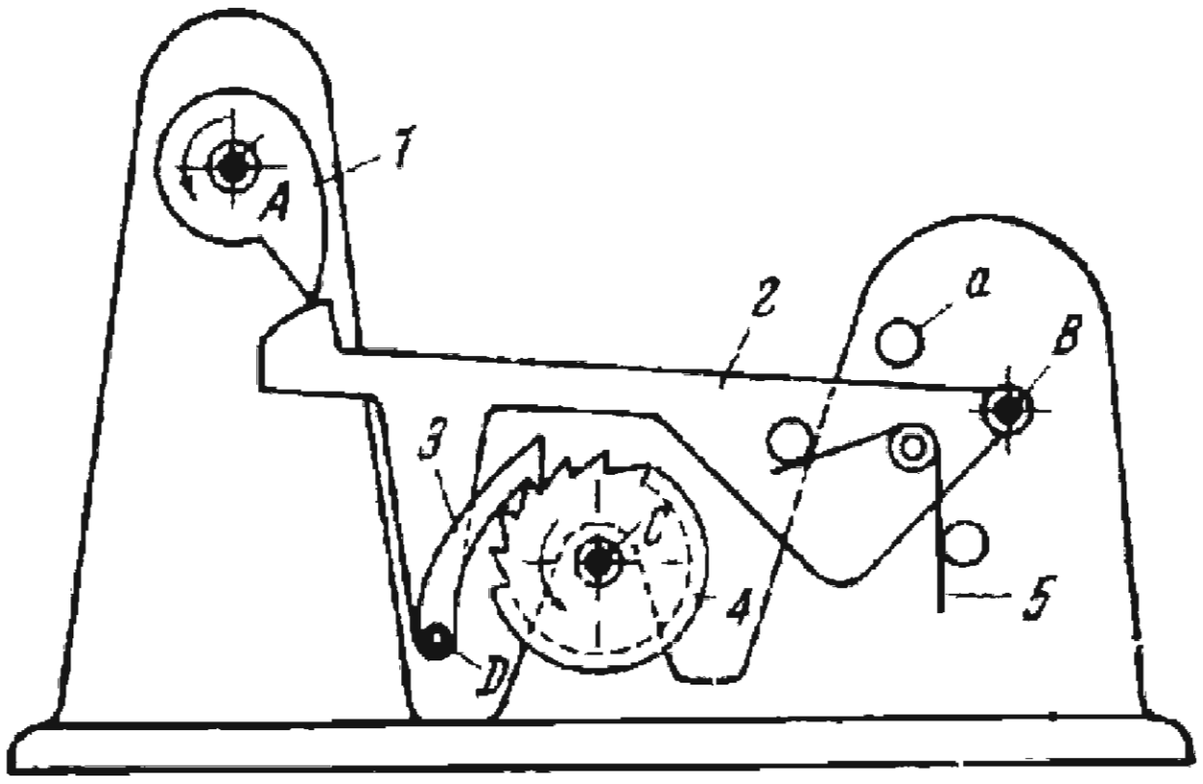
2. GENERAL-PURPOSE FIVE-LINK MECHANISMS
(1803 through 1806)

1803	CAM-DRIVEN LEVER-RATCHET MECHANISM	LR 5L

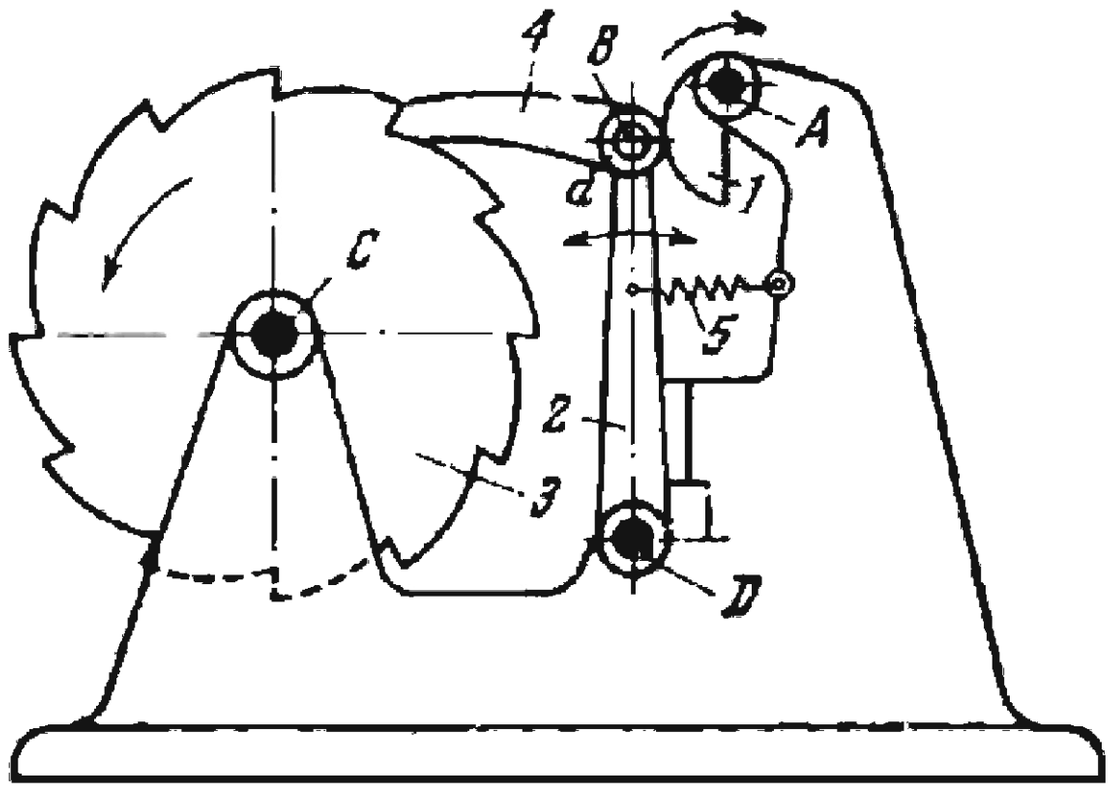


Face cam *1*, rotating about fixed axis *A*, has a cam profile of which portion *abc* is along a circular arc whose centre is at axis *A*. Ratchet wheel *3* is turned intermittently about fixed axis *D* by pawl *4* which is connected by turning pair *B* to lever *2*. Lever *2* turns about fixed axis *C* and has roll *E* which is the follower of face cam *1*. When roll *E* is in portion *abc* of the cam profile, lever *2* is at rest. In portion *cd*, pawl *4* turns ratchet wheel *3*. In portion *da*, the pawl slides back to engage the next tooth.

1804	CAM-DRIVEN LEVER-RATCHET MECHANISM	LR 5L



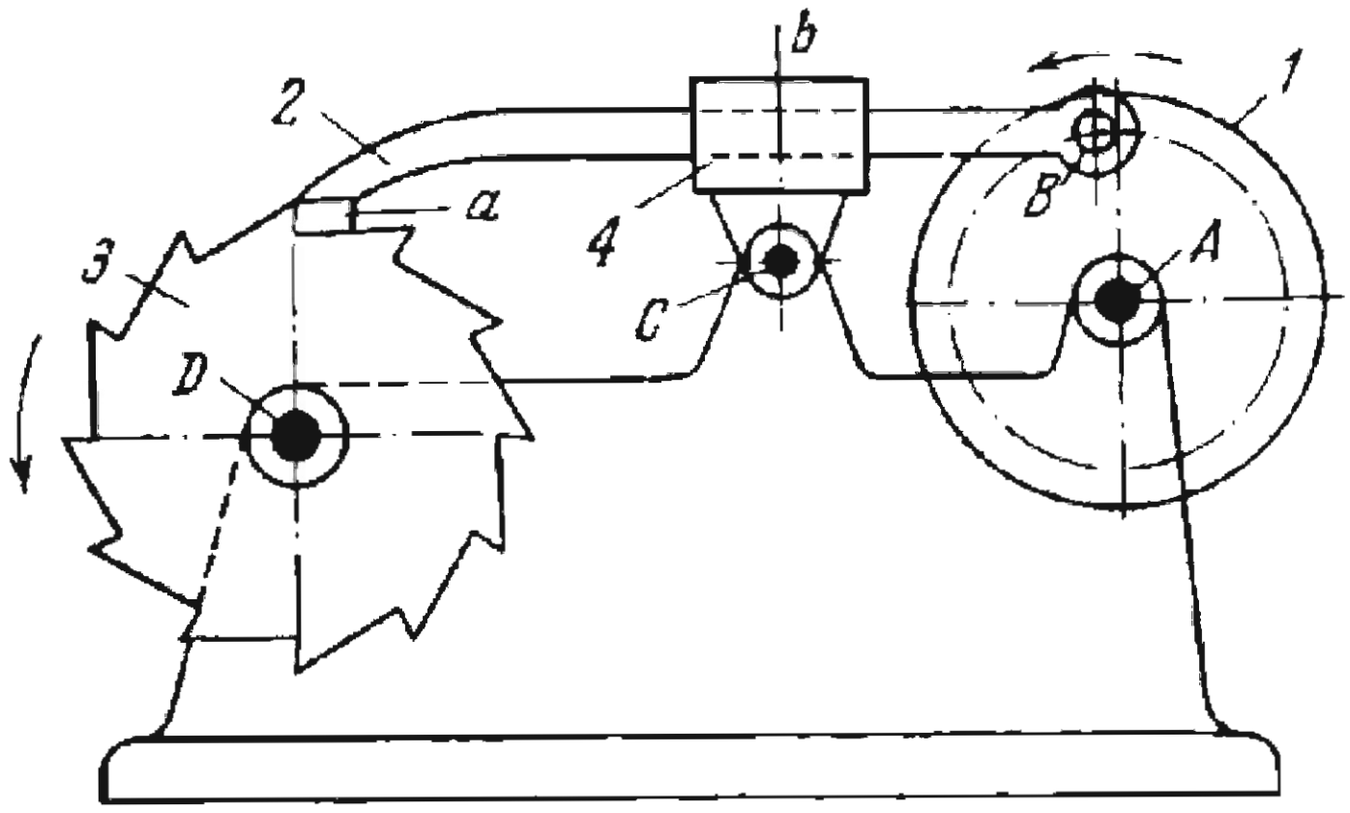
Cam *1* rotates about fixed axis *A* and oscillates lever *2* which turns about fixed axis *B*. Connected to lever *2* by turning pair *D* is pawl *3* which engages ratchet wheel *4*. Flat spring *5* holds lever *2* against cam *1*. The angle of oscillation of lever *2* is limited by stop *a*. When cam *1* rotates about axis *A*, lever *2* is oscillated between its upper and lower positions about axis *B*. In the down stroke of the lever, pawl *3* turns ratchet wheel *4* by one tooth about fixed axis *C*.



Rachet wheel *3* rotates about fixed axis *C*. Cam *1* rotates about fixed axis *A* and imparts motion to roll *a* which rotates about axis *B* of lever *2*. Spring *5* holds roll *a* against cam *1*. When cam *1* rotates clockwise, lever *2* oscillates about fixed axis *D* and pawl *4* turns ratchet wheel *3* intermittently. In one complete revolution of cam *1*, wheel *3* is turned through the angle

$$\alpha = \frac{360^\circ}{z}$$

where z is the number of teeth on ratchet wheel *3*.



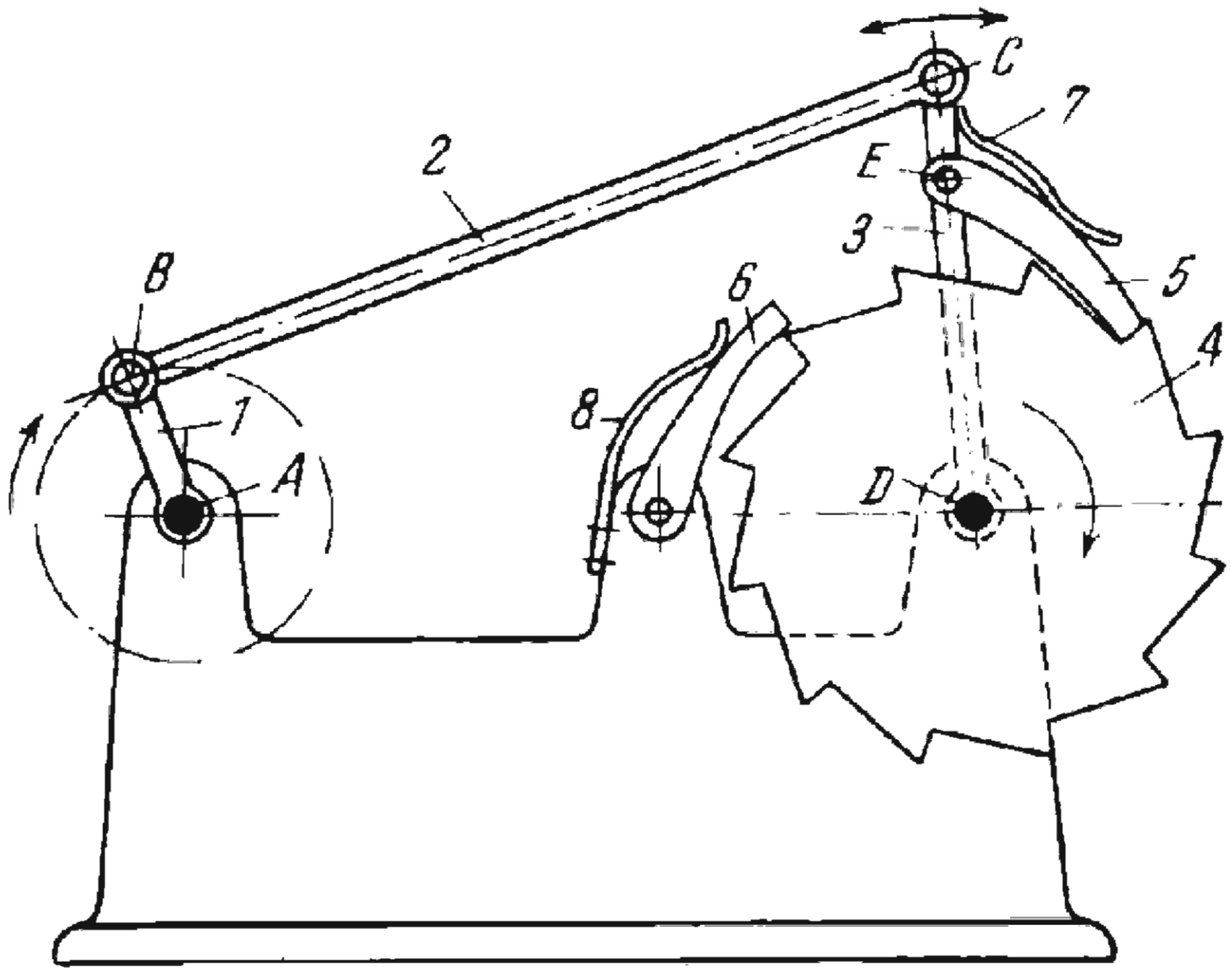
Lever *2* is connected by turning pair *B* to link *1* and slides in guide *b* of guiding link *4* which turns about fixed axis *C*. Ratchet wheel *3* rotates about fixed axis *D*. When link *1* rotates about fixed axis *A*, lug *a* of lever *2* turns ratchet wheel *3* intermittently counterclockwise. In one complete revolution of link *1*, lever *2* turns wheel *3* through the angle

$$\alpha = \frac{360^\circ}{z}$$

where z is the number of teeth on ratchet wheel *3*.

3. GENERAL-PURPOSE SIX-LINK MECHANISMS (1807 through 1818)

1807	LINKWORK-DRIVEN LEVER-RATCHET MECHANISM	LR 6L

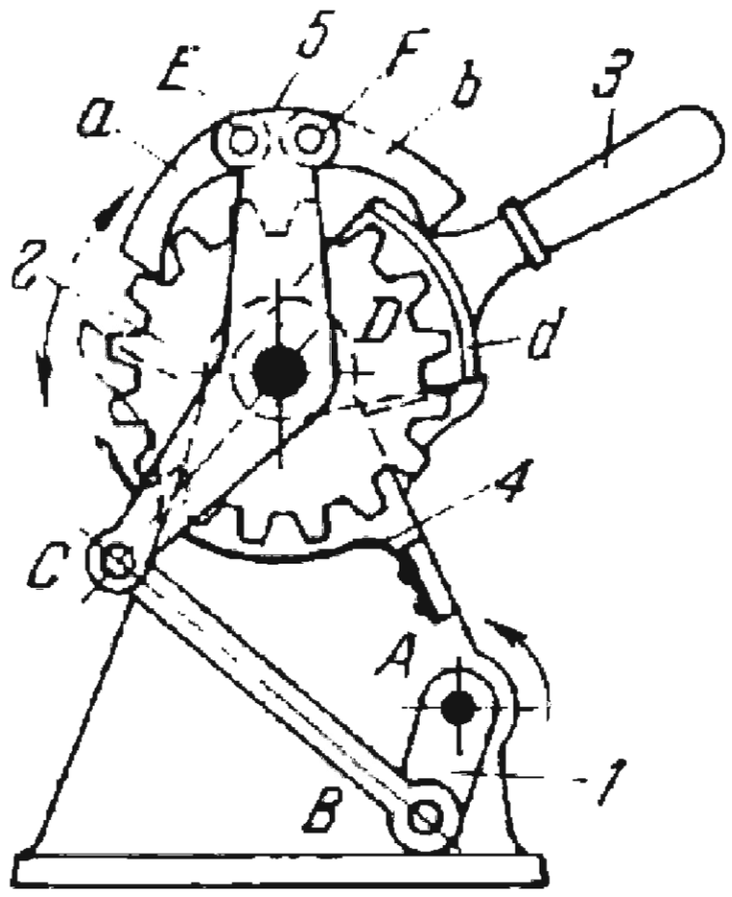


Ratchet wheel *4* rotates about fixed axis *D*. Link *3* is the rocker arm of four-bar linkage *ABCD* and is connected by turning pair *E* to pawl *5* which engages wheel *4*. Spring *7* holds pawl *5* in contact with ratchet wheel *4*. In one revolution of crank *1* about fixed axis *A*, pawl *5* turns wheel *3* intermittently clockwise through the angle

$$\alpha = \frac{360^\circ}{z}$$

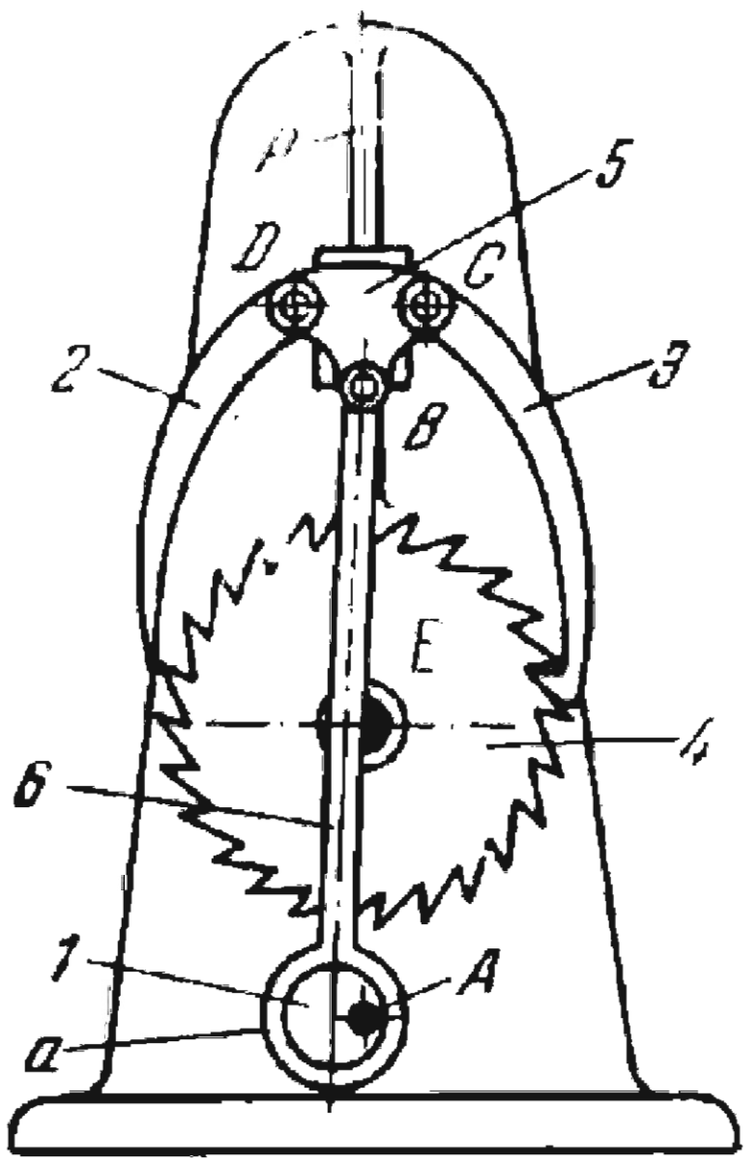
where *z* is the number of teeth on ratchet wheel *4*. Pawl *6* and spring *8* prevent reverse rotation of ratchet wheel *4*.

1808	LINKWORK-DRIVEN LEVER-RATCHET MECHANISM	LR 6L



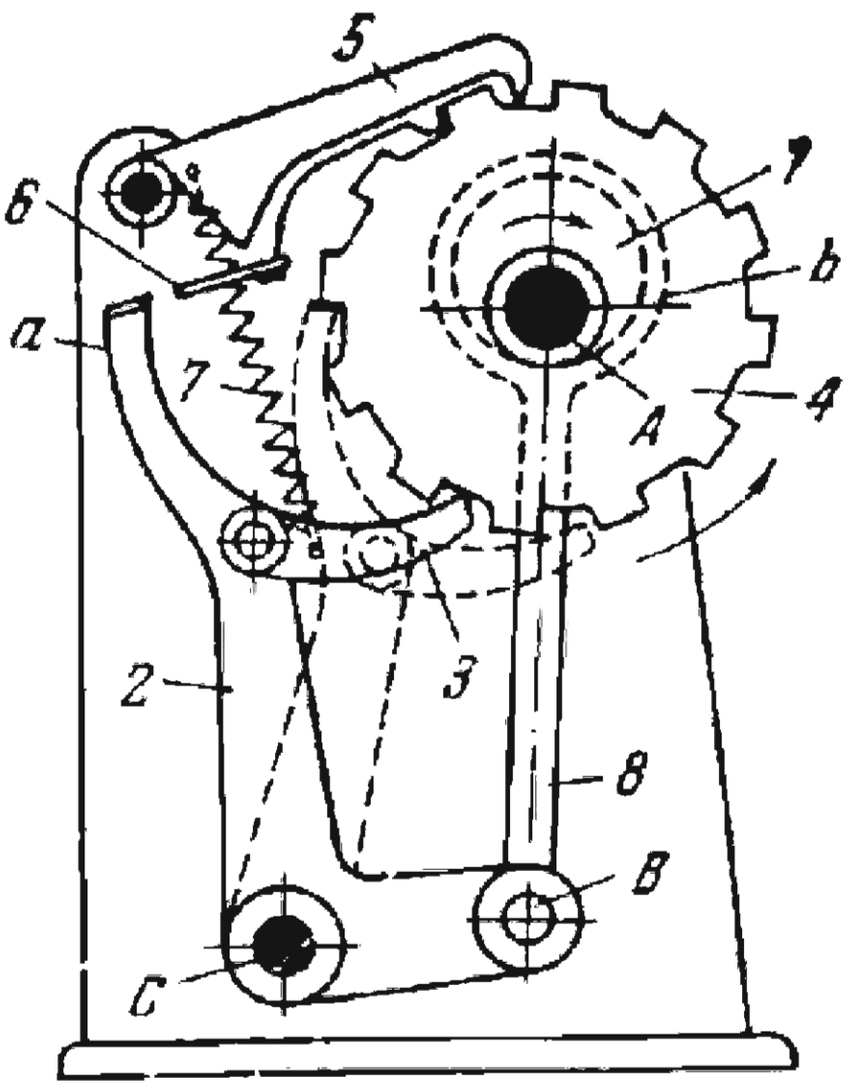
Rocker arm *5* of four-bar linkage *ABCD* is connected by turning pairs *E* and *F* to pawls *a* and *b*. Ratchet wheel *2* rotates about fixed axis *D*. When crank *1* rotates about fixed axis *A*, pawl *a* turns ratchet wheel *2* intermittently counterclockwise. During this time, pawl *b* is kept out of engagement by shield *d* on lever *3*. Lever *3* can be turned to bring pawl *b* into engagement and take pawl *a* out of engagement with wheel *2*. Then wheel *2* will be turned intermittently clockwise. Spring *4* serves to brake the motion of wheel *2*.

1809	SLIDER-CRANK-DRIVEN LEVER-RATCHET MECHANISM	LR 6L



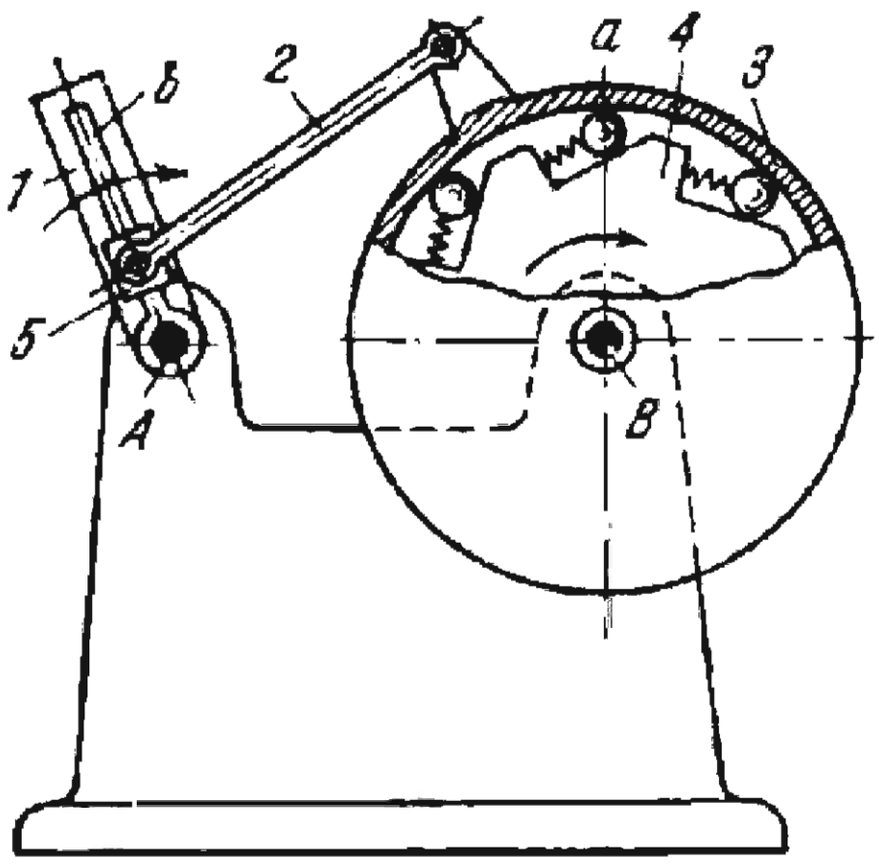
Round eccentric *1* rotates about fixed axis *A*. Connecting rod *6* has collar *a* encircling eccentric *1*. Slider *5* moves along fixed guide *p* and is connected by turning pair *B* to connecting rod *6* and by turning pairs *D* and *C* to pawls *2* and *3* which turn ratchet wheel *4* intermittently counterclockwise about fixed axis *E*. Pawl *2* engages wheel *4* when slider *5* moves downward and pawl *3* when it moves upward. When eccentric *1* rotates at uniform velocity, wheel *4* rotates nonuniformly.

1810	ECCENTRIC-DRIVEN LEVER-RATCHET MECHANISM	LR 6L



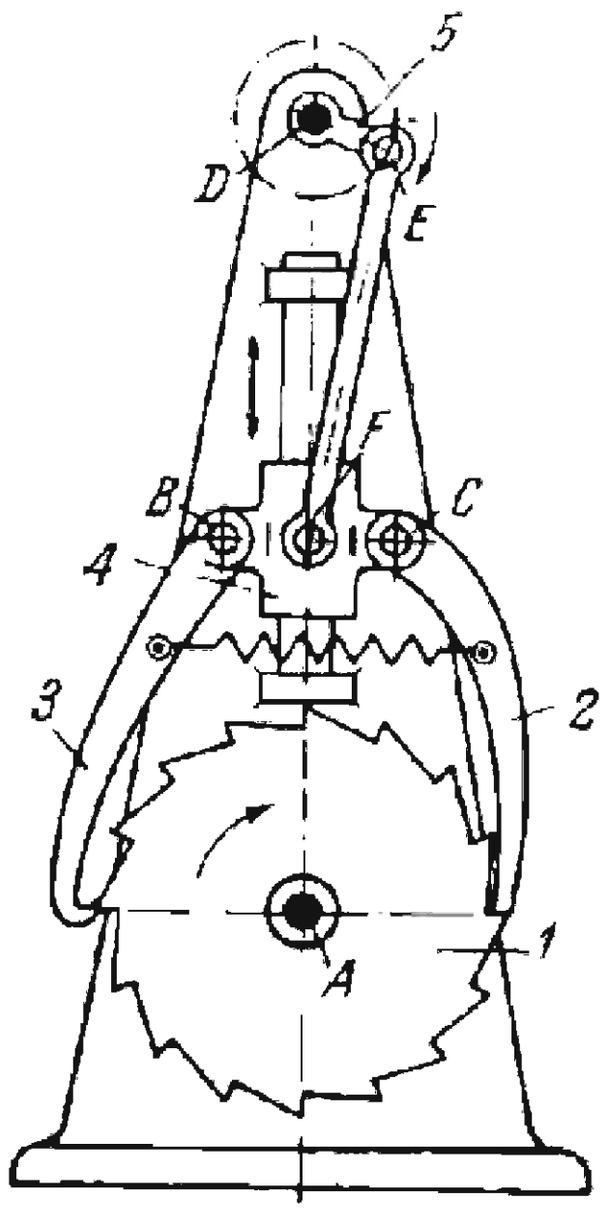
Round eccentric *1* rotates about fixed axis *A* and is encircled by collar *b* of link *8*. Bell-crank *2* turns about fixed axis *C* and is connected by turning pair *B* to link *8*. When eccentric *1* rotates about axis *A*, pawl *3*, connected by a turning pair to lever *2*, turns ratchet wheel *4* intermittently counterclockwise about axis *A*. Spring *7* holds pawls *3* and *5* in engagement with wheel *4*. Locking pawl *5* positively locks ratchet wheel *4* during the idle period. When pawl *3* begins to turn wheel *4*, the upper end *a* of lever *2* engages flat spring *6*, thereby lifting locking pawl *5* and allowing ratchet wheel *4* to turn.

1811	LEVER-RATCHET FREE-WHEELING CLUTCH MECHANISM	LR 6L



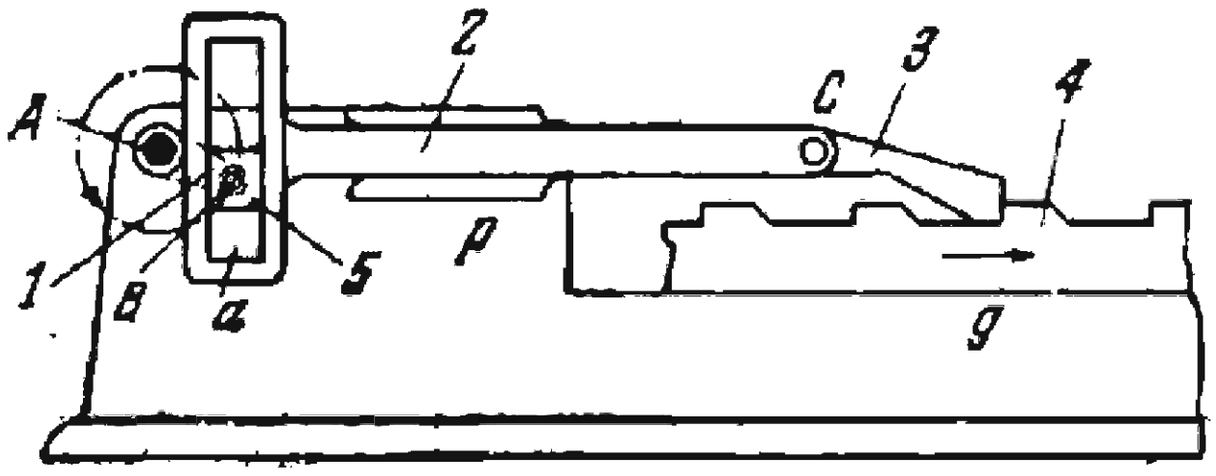
Link *3* oscillates about fixed axis *B*. It is driven through connecting rod *2* by the oscillation of crank *1* about fixed axis *A*. By means of rolls *a*, link *3* imparts intermittent rotary clockwise motion to ratchet wheel *4* about axis *B*. The angle of rotation of link *3* is varied by changing the length of crank *1*. This is done by adjusting slider *5* along slot *b* and clamping it in the required position.

1812	SLIDER-CRANK-DRIVEN LEVER-RATCHET MECHANISM	LR 6L



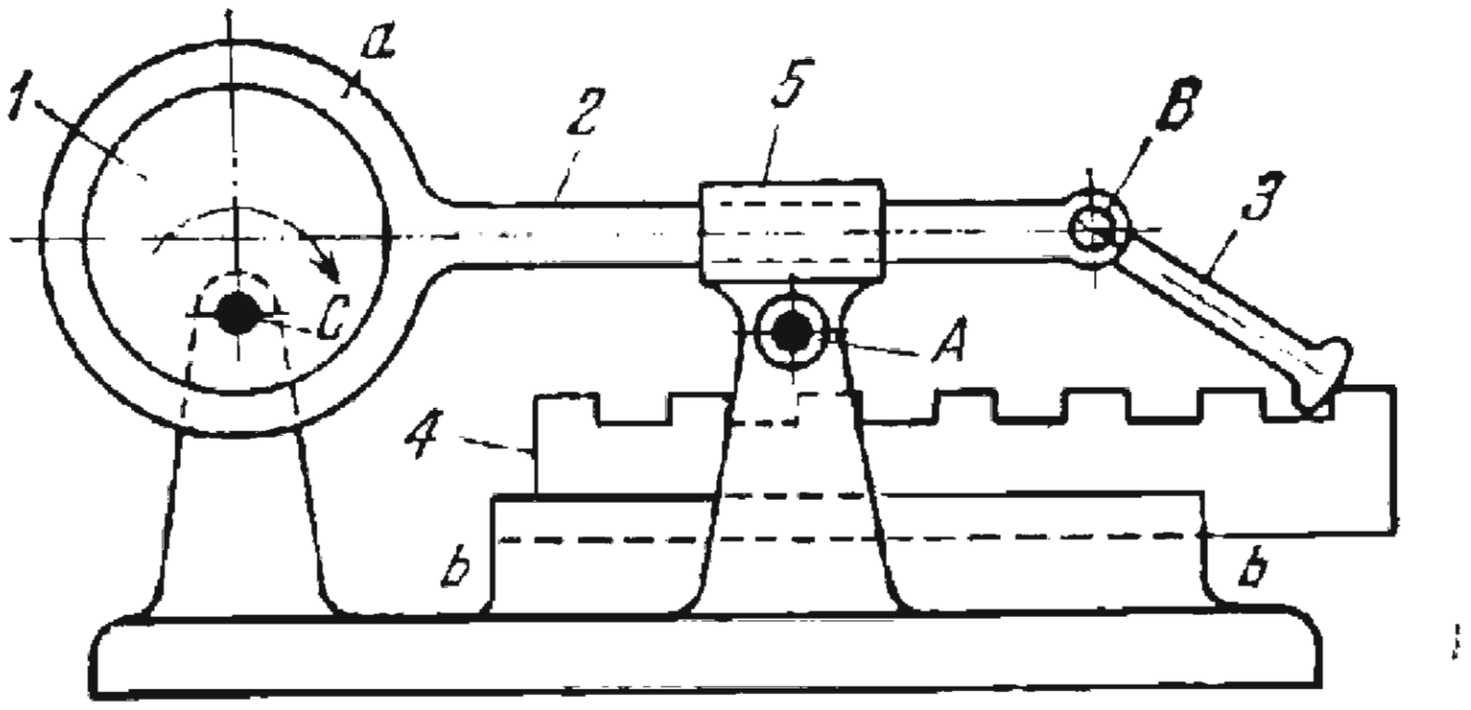
Ratchet wheel *1* is turned clockwise about fixed axis *A* by pawls *2* and *3* which are connected by turning pairs *C* and *B* to slider *4* of slider-crank linkage *DEF*. Pawl *2* engages wheel *1* when slider *4* moves downward, and pawl *3* when it moves upward. In one complete revolution of crank *5* about fixed axis *D*, ratchet wheel *1* turns through the angle $\alpha = 720°/z$, where z is the number of teeth on ratchet wheel *1*.

1813	LEVER-RATCHET MECHANISM WITH A RATCHET-TOOTH RACK	LR 6L



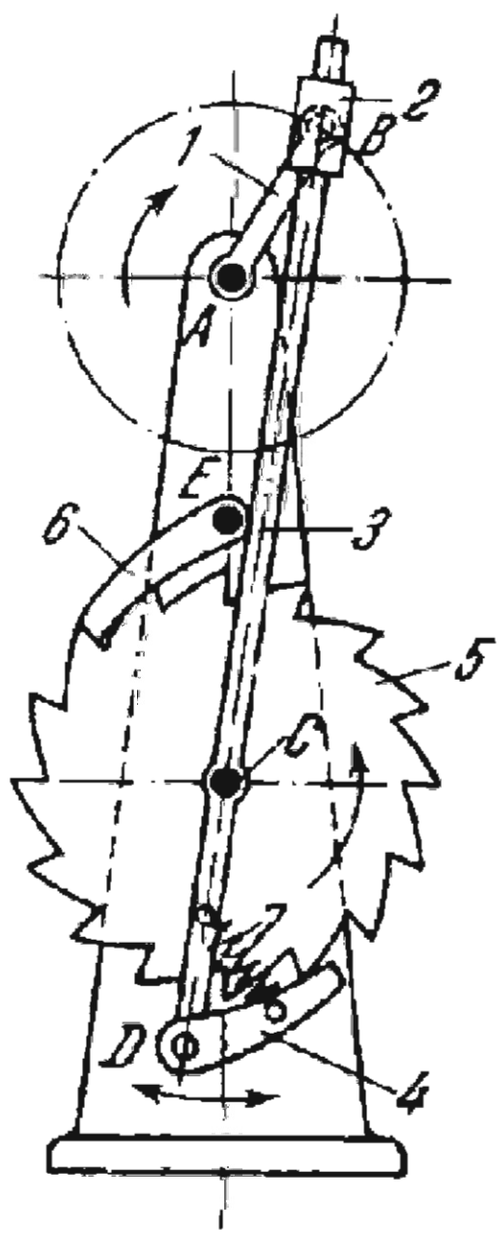
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to slider *5* which moves along slot *a* of link *2*. Link *2* slides along fixed guide *p* and is connected by turning pair *C* to pawl *3*. Pawl *3* engages ratchet-tooth rack *4* which slides along fixed guide *g*. When crank *1* rotates about axis *A*, slotted link *2* reciprocates and pawl *3* moves rack *4* intermittently.

1814	LEVER-RATCHET MECHANISM WITH A RATCHET-TOOTH RACK	LR 6L



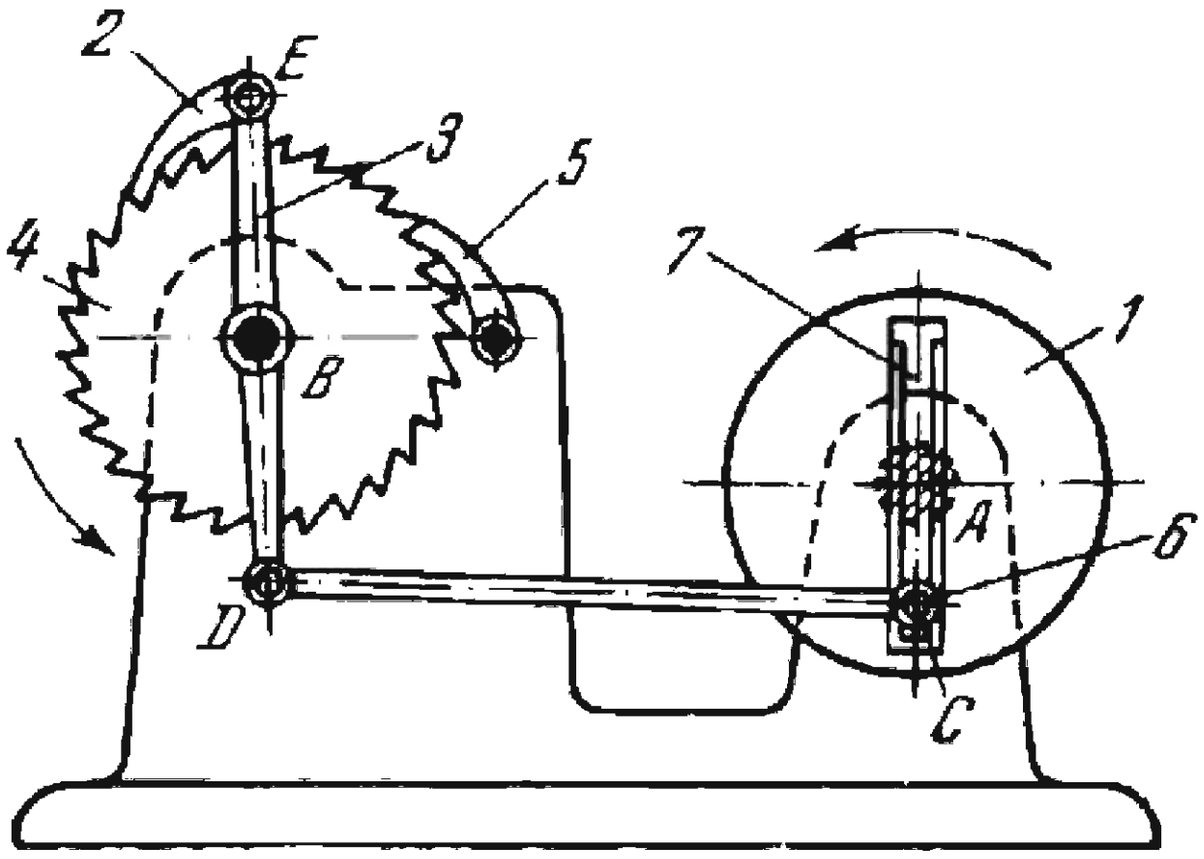
Connecting rod *2* has collar *a* encircling round eccentric *1* which rotates about fixed axis *C*. When eccentric *1* rotates about axis *C*, connecting rod *2* and pawl *3* move rack *4* intermittently to the right along fixed guides *b*-*b*. Pawl *3* can be turned over, about axis *B*, in which case the rack moves to the left.

1815	LINK-GEAR-DRIVEN LEVER-RATCHET MECHANISM	LR 6L



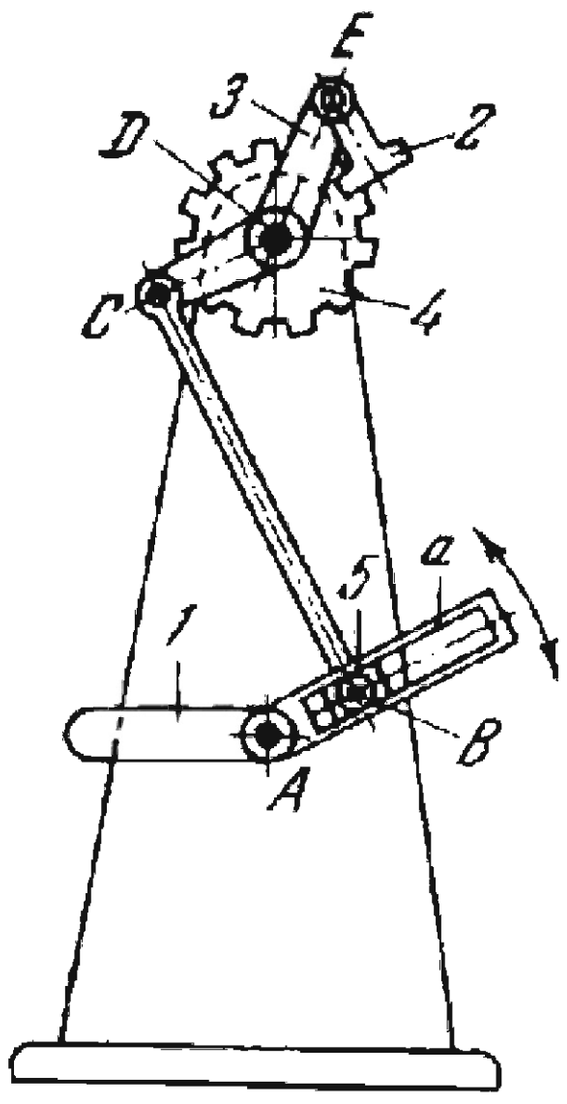
Ratchet wheel *5* rotates about fixed axis *C*. Link *3* of link-gear mechanism *ABC* is connected by turning pair *D* to pawl *4* which is held against ratchet wheel *5* by spring *7*. In one complete revolution of crank *1* about fixed axis *A*, pawl *4* turns ratchet wheel *5* through the angle $\alpha = 360°/z$, where z is the number of teeth on ratchet wheel *5*. Pawl *6* turns freely about fixed axis *E* and prevents reverse rotation of ratchet wheel *5*.

1816 LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE RATCHET WHEEL — LR 6L

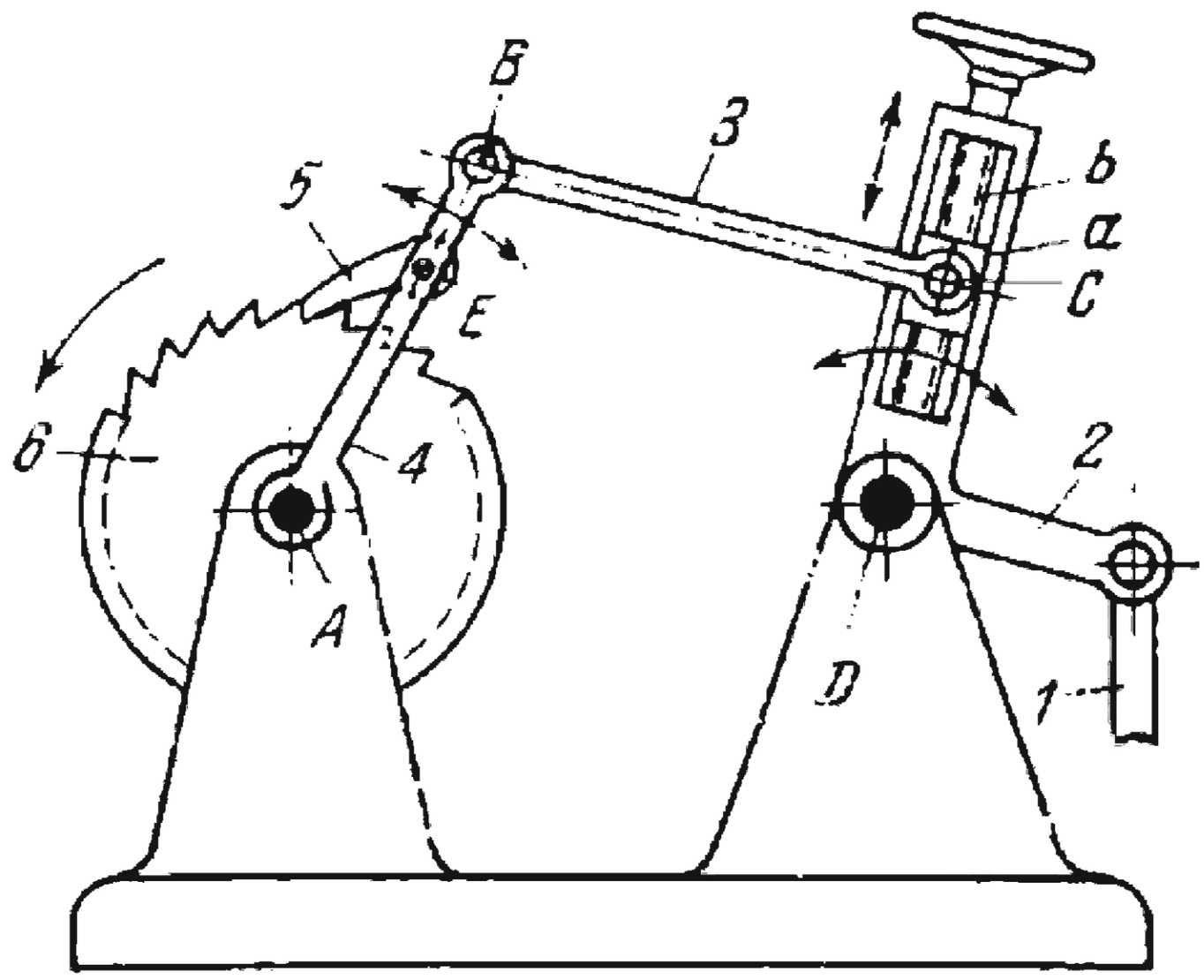


Link *1* rotates about fixed axis *A*. Link *3* and ratchet wheel *4* turn independently of each other about fixed axis *B*. Link *3* is connected by turning pair *E* to pawl *2* which engages ratchet wheel *4*. When crank *1* of four-bar linkage *ACDB* rotates about axis *A*, pawl *2* turns ratchet wheel *4* intermittently counterclockwise. Pawl *5* prevents clockwise rotation of wheel *4*. The angular velocity (angle of rotation) of the ratchet wheel can be varied by adjusting slider *6* along slotted link *7* and clamping it in the required position.

1817 LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE RATCHET WHEEL — LR 6L



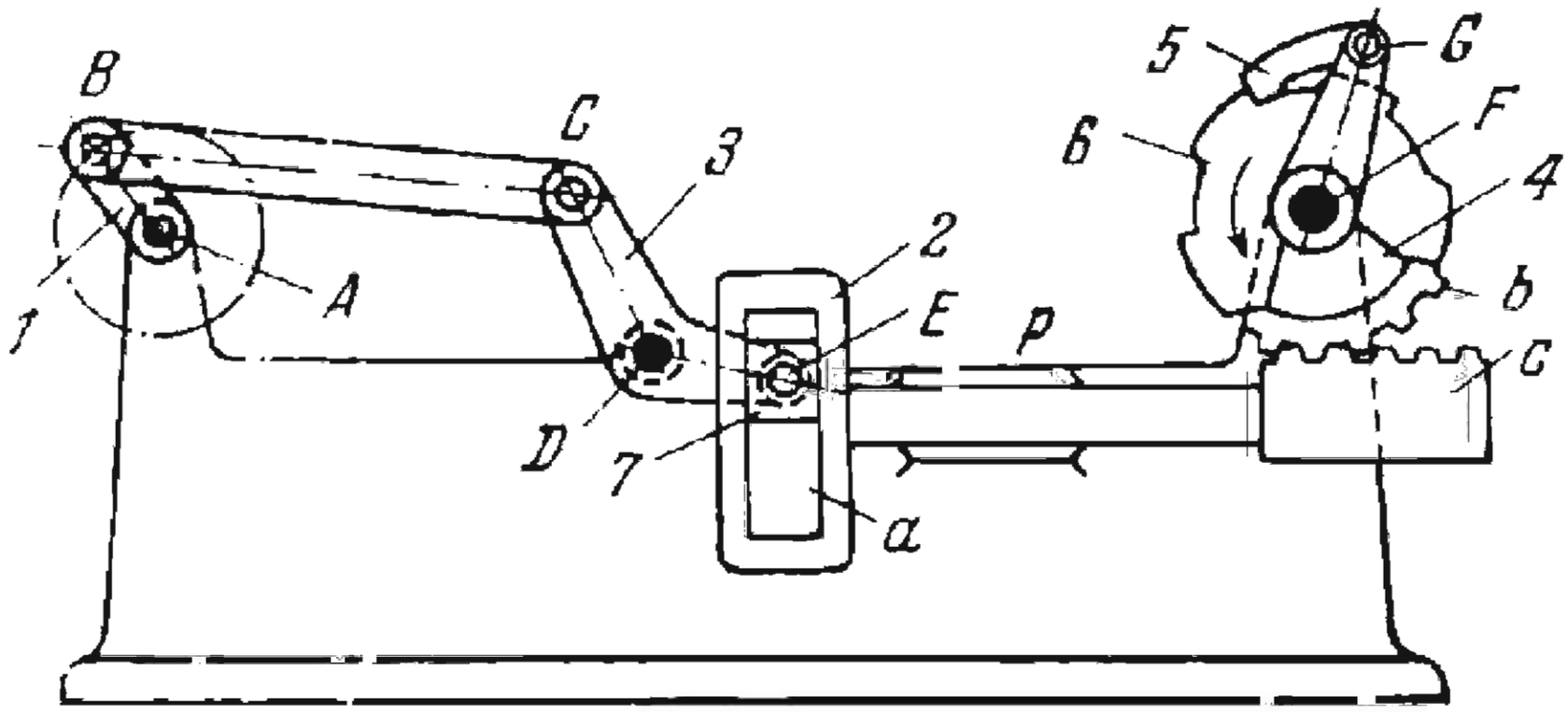
Pawl *2* is connected by turning pair *E* to rocker arm *3* of four-bar linkage *ABCD*. When lever *1* oscillates about fixed axis *A* pawl *2* turns ratchet wheel *4* intermittently about fixed axis *D*. The angular velocity (angle of rotation) of the ratchet wheel can be varied by adjusting slider *5* along slot *a* of lever *1* and clamping it in the required position.



Ratchet wheel *6* rotates about fixed axis *A*. Link *3* is connected by turning pair *B* to link *4*, turning about axis *A*, and by turning pair *C* to nut *a*. Pawl *5* is connected by turning pair *E* to link *4* and engages wheel *6*. When link *2* of four-bar linkage *DCBA* is oscillated by tie-rod *1*, pawl *5* turns ratchet wheel *6* intermittently counterclockwise. The rate of feed (angle of rotation of ratchet wheel *6*) can be varied by adjusting slider (nut) *a* along the slot in link *2* by means of screw *b* and clamping it in the required position.

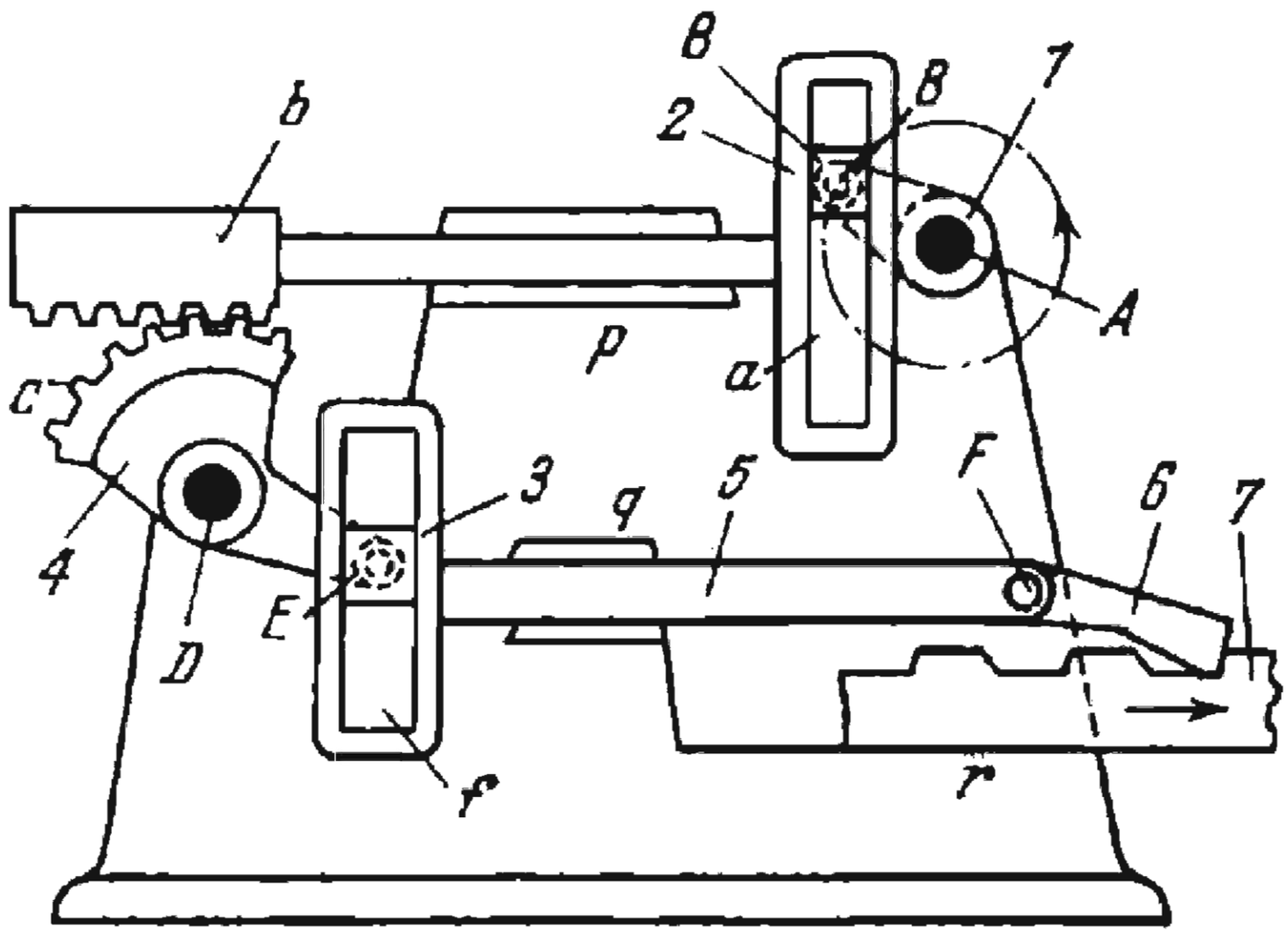
4. GENERAL-PURPOSE MULTIPLE-LINK MECHANISMS (1819 through 1834)

1819	LEVER-RATCHET MECHANISM WITH A GEAR RACK	LR ML



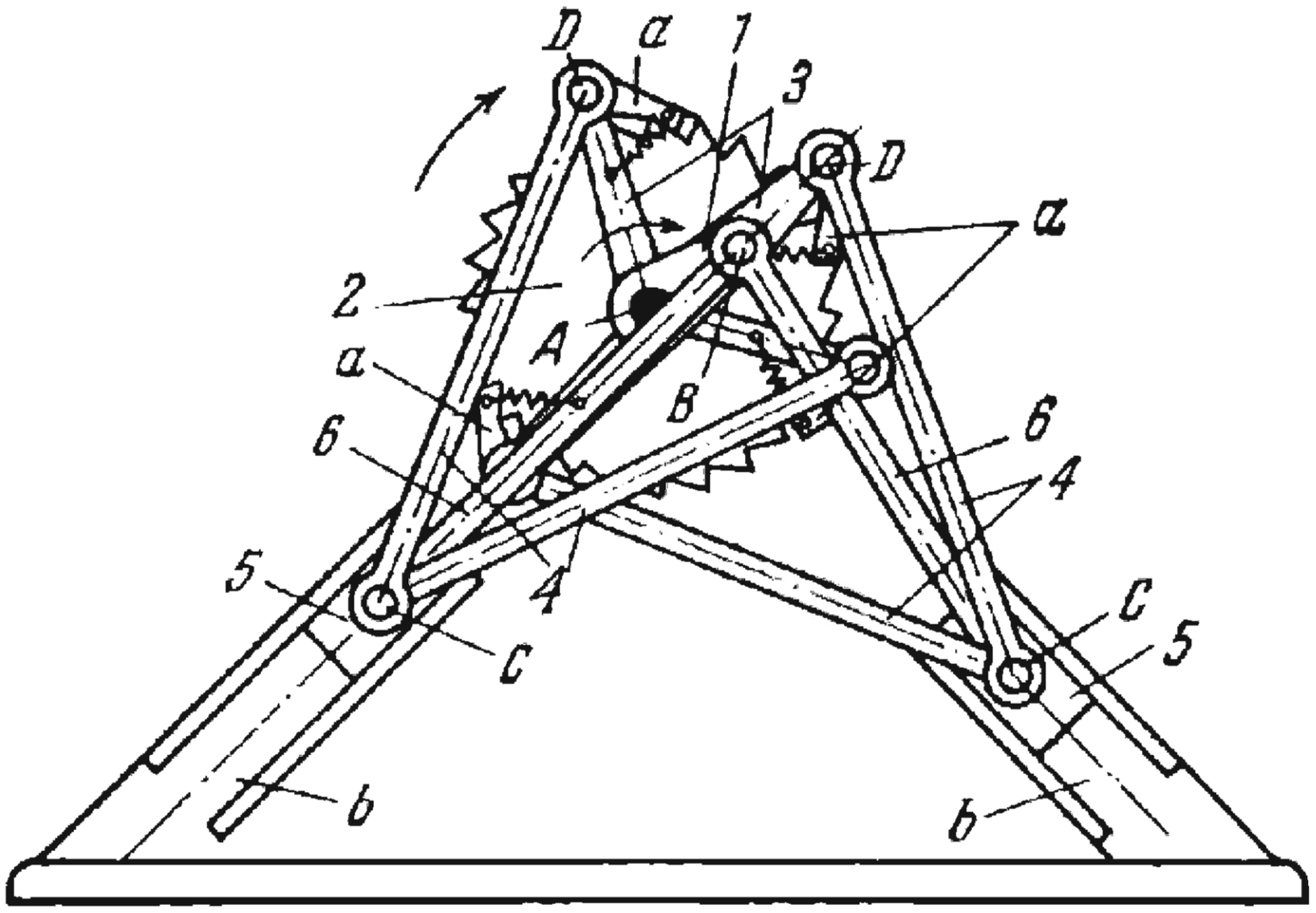
Rocker arm *3* of four-bar linkage *ABCD* is connected by turning pair *E* to slider *7* which moves along slot *a* of link *2*. Link *2* slides in fixed guide *p* and has gear rack *c* which meshes with gear segment *b* of link *4*. Link *4* turns about fixed axis *F* and is connected by turning pair *G* to pawl *5* which engages ratchet wheel *6*. Ratchet wheel *6* rotates about axis *F* independently of link *4*. When crank *1* rotates about fixed axis *A*, link *2* and rack *c* reciprocate while link *4* with gear segment *b* oscillate. At this, pawl *5* turns ratchet wheel *6* intermittently counterclockwise.

1820	LEVER-RATCHET MECHANISM WITH A RATCHET-TOOTH RACK	LR ML



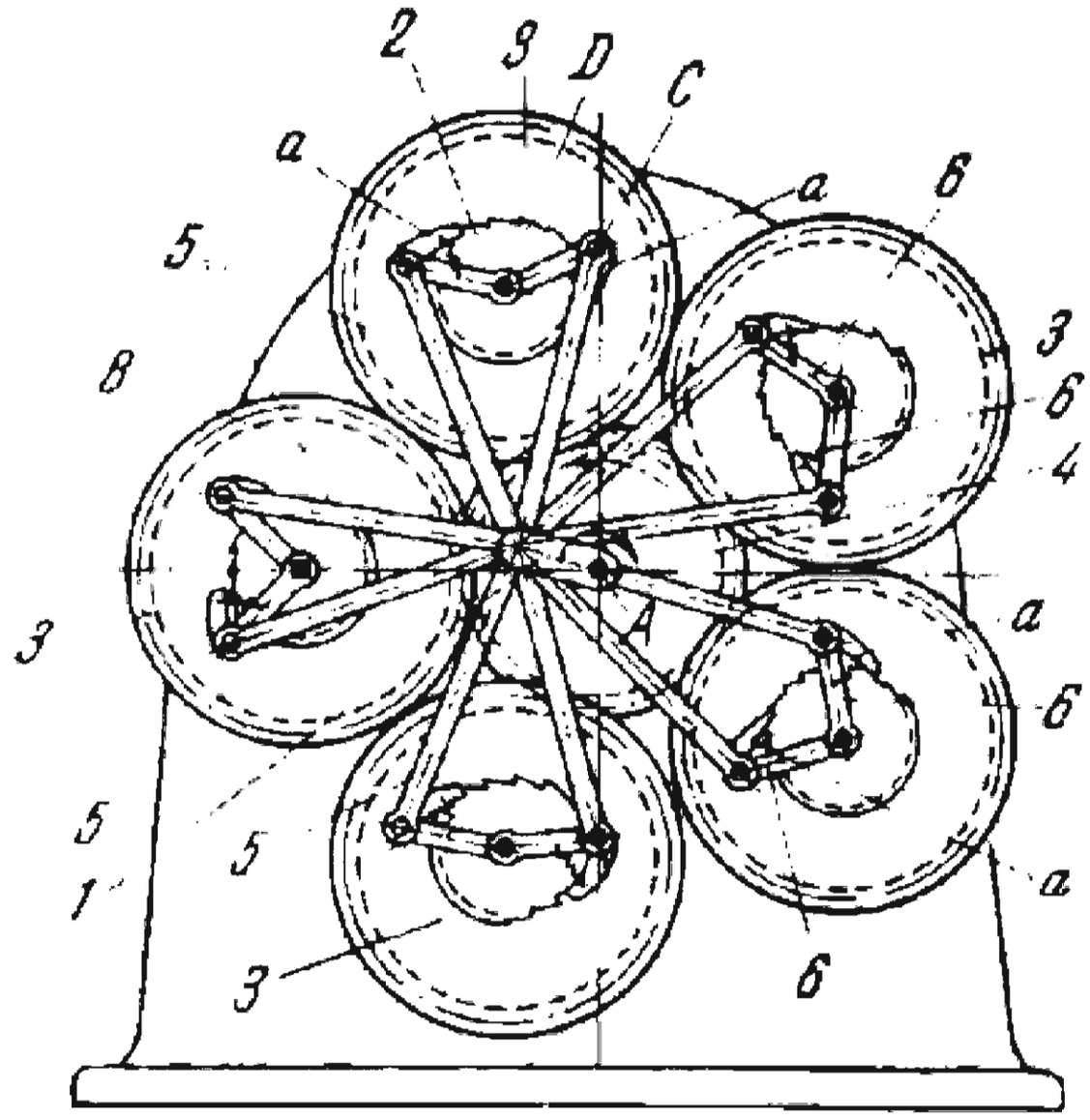
Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to slider *8* which moves along slot *a* of link *2*. Link *2* slides in fixed guide *p* and has gear rack *b* meshing with gear segment *c* of link *4* which turns about fixed axis *D*. Link *4* is connected by turning pair *E* to slider *3* which moves along slot *f* of link *5*. Link *5* slides in fixed guide *q* and is connected by turning pair *F* to pawl *6* which engages ratchet-tooth rack *7* sliding along fixed guide *r*. When crank *1* rotates about axis *A*, slotted link *2* with rack *b* reciprocates, link *4* oscillates, slotted link *5* reciprocates and pawl *6* moves rack *7* intermittently to the right.

1821	SLIDER-CRANK-DRIVEN LEVER-RATCHET MECHANISM	LR ML



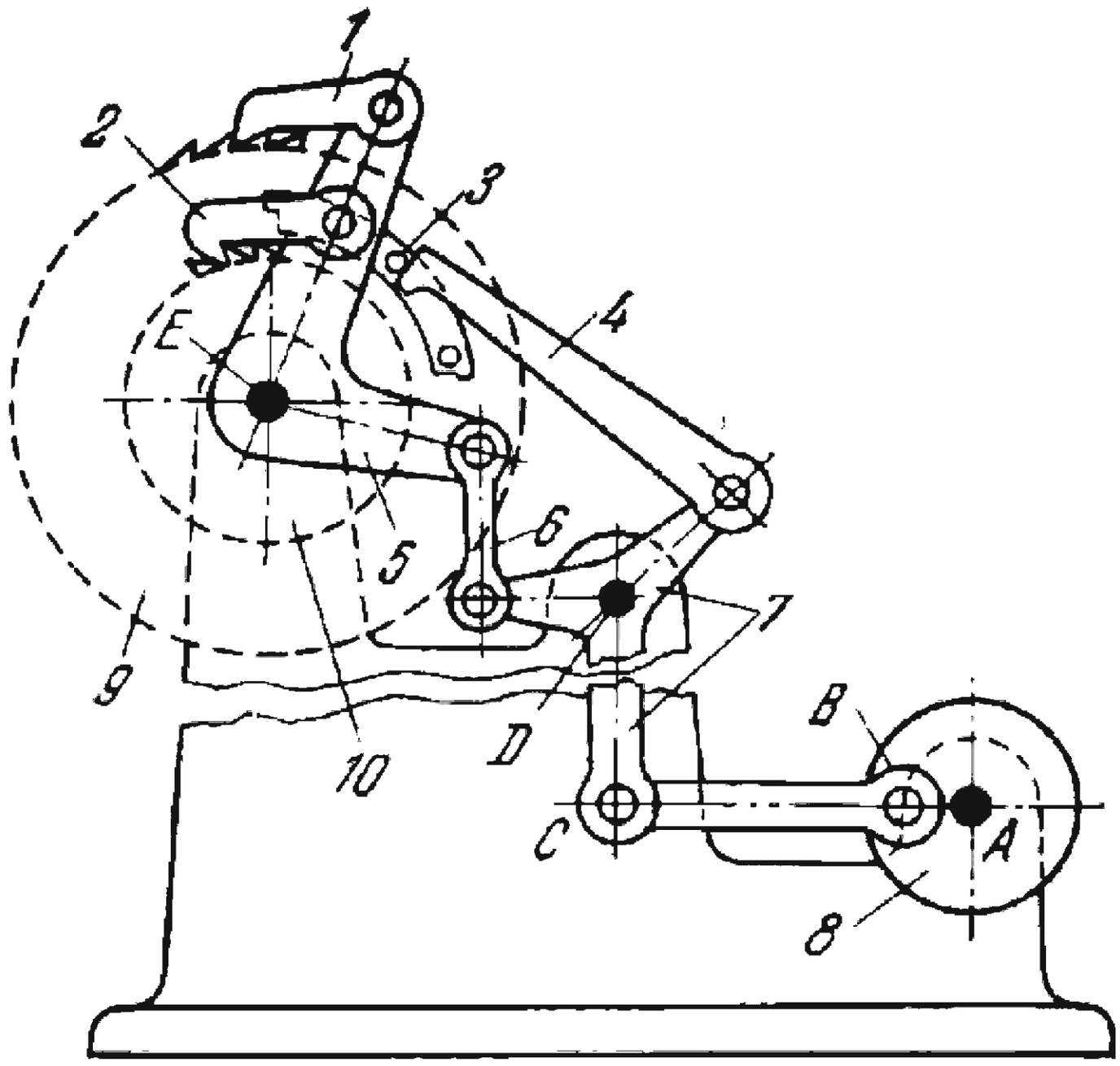
Crank *1* rotates about fixed axis *A* and is connected by turning pairs *B* to connecting rods *6* which, in turn, are connected by turning pairs *C* to sliders *5* moving along fixed guides *b*. Links *4* are connected by turning pairs *C* to sliders *5* and by turning pairs *D* to links *3*. Links *3* turn about axis *A* independently of crank *1* and are connected by turning pairs *D* to pawls *a* which engage ratchet wheel *2*. When crank *1* rotates about axis *A*, ratchet wheel *2* is turned intermittently clockwise about axis *A*.

1822	LEVER-RATCHET MECHANISM WITH GEARS	LR ML



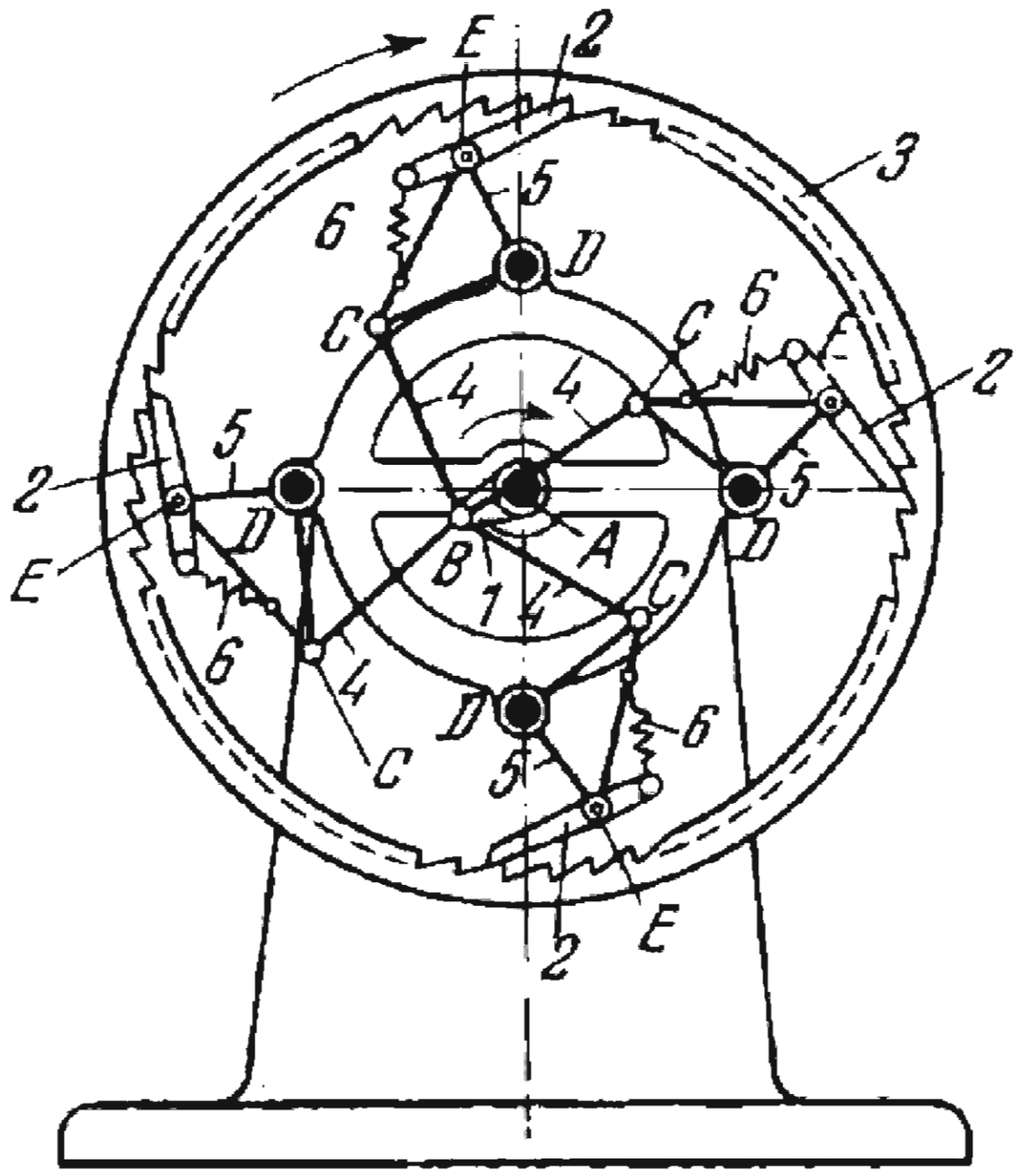
Crank *1* rotates about fixed axis *A* and is connected by turning pairs *B* to connecting rods *5* which, in turn, are connected by turning pairs *C* to rocker arms *6* turning about fixed axes *D*. The lengths of all connecting rods *5* are equal to one another, as are those of all rocker arms *6*. Each four-bar linkage *ABCD* is connected by turning pair *C* to a pawl *a* which engages a ratchet wheel *2*. When crank *1* rotates about axis *A*, pawls *a* turn ratchet wheels *2* intermittently clockwise. Rigidly attached to ratchet wheels *2* are gears *3* which mesh with driven gear *4* which they turn intermittently counterclockwise.

1823	LEVER-RATCHET MECHANISM WITH TWO RATCHET WHEELS	LR ML

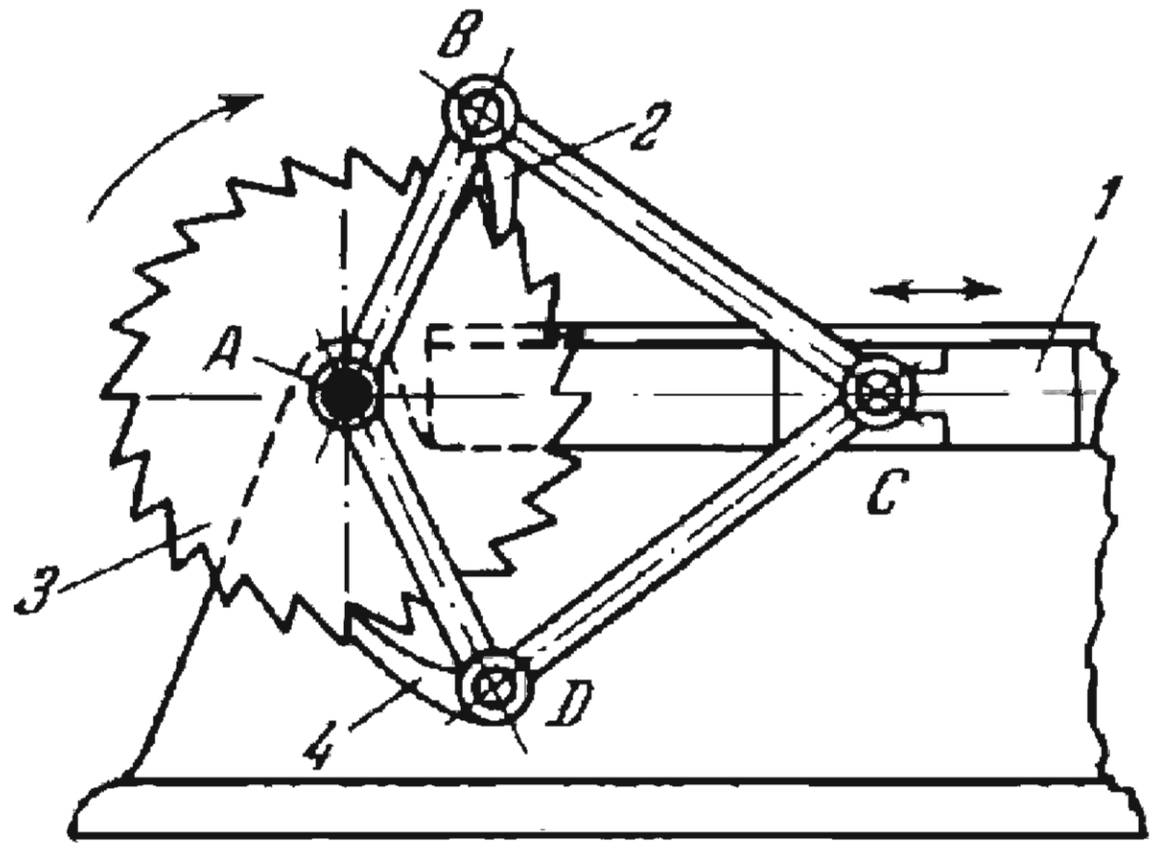


Crank *8* rotates about fixed axis *A*. Rocker arm *7* of four-bar linkage *ABCD* turns about fixed axis *D*. Bent lever *5* turns about fixed axis *E*. When crank *8* rotates about axis *A*, triple rocker arm *7* oscillates and, through connecting rod *6*, it also oscillates bent lever *5*. Link *4* is connected by a turning pair to link *7* and engages pins *3*. Connected by turning pairs to bent lever *5* are pawl *2* which engages ratchet wheel *10* and pawl *1* which engages ratchet wheel *9*. When lever *5* turns clockwise it turns ratchet wheel *10*, and when it turns counter-clockwise, it turns ratchet wheel *9*. Wheel *9* has a rim along which link *4* slides. Mounted on the rim of wheel *9* are pins *3* which link *4* engages to impart supplementary motion to ratchet wheel *9*.

1824	FOUR-PAWL LEVER-RATCHET MECHANISM	LR ML

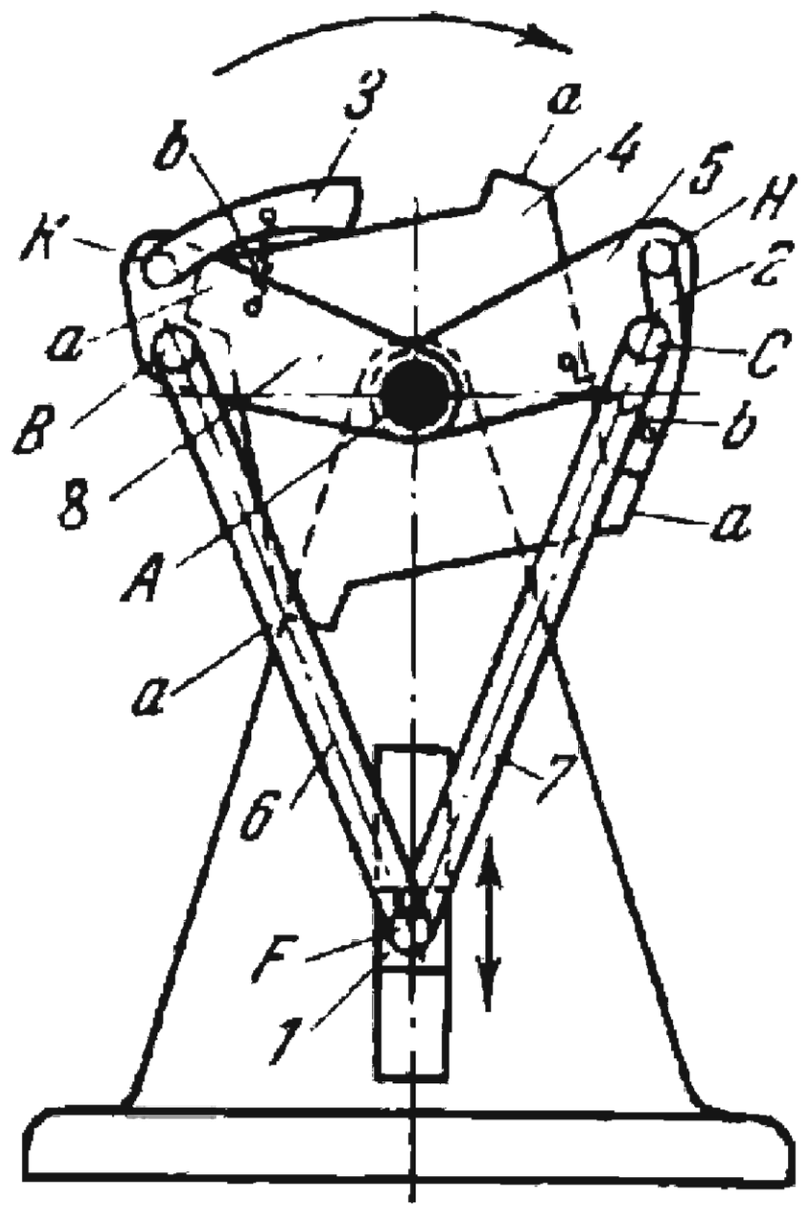


Crank *1* rotates about fixed axis *A* and is connected by turning pairs *B* to four connecting rods *4* which, in turn, are connected by turning pairs *C* to bent levers *5*. Levers *5* turn about fixed axes *D* and are connected by turning pairs *E* to pawls *2* which engage the teeth of internal ratchet wheel *3* and are held in contact with them by springs *6*. When crank *1* rotates about axis *A*, pawls *2* impart intermittent clockwise motion to ratchet wheel *3*, also about axis *A*.



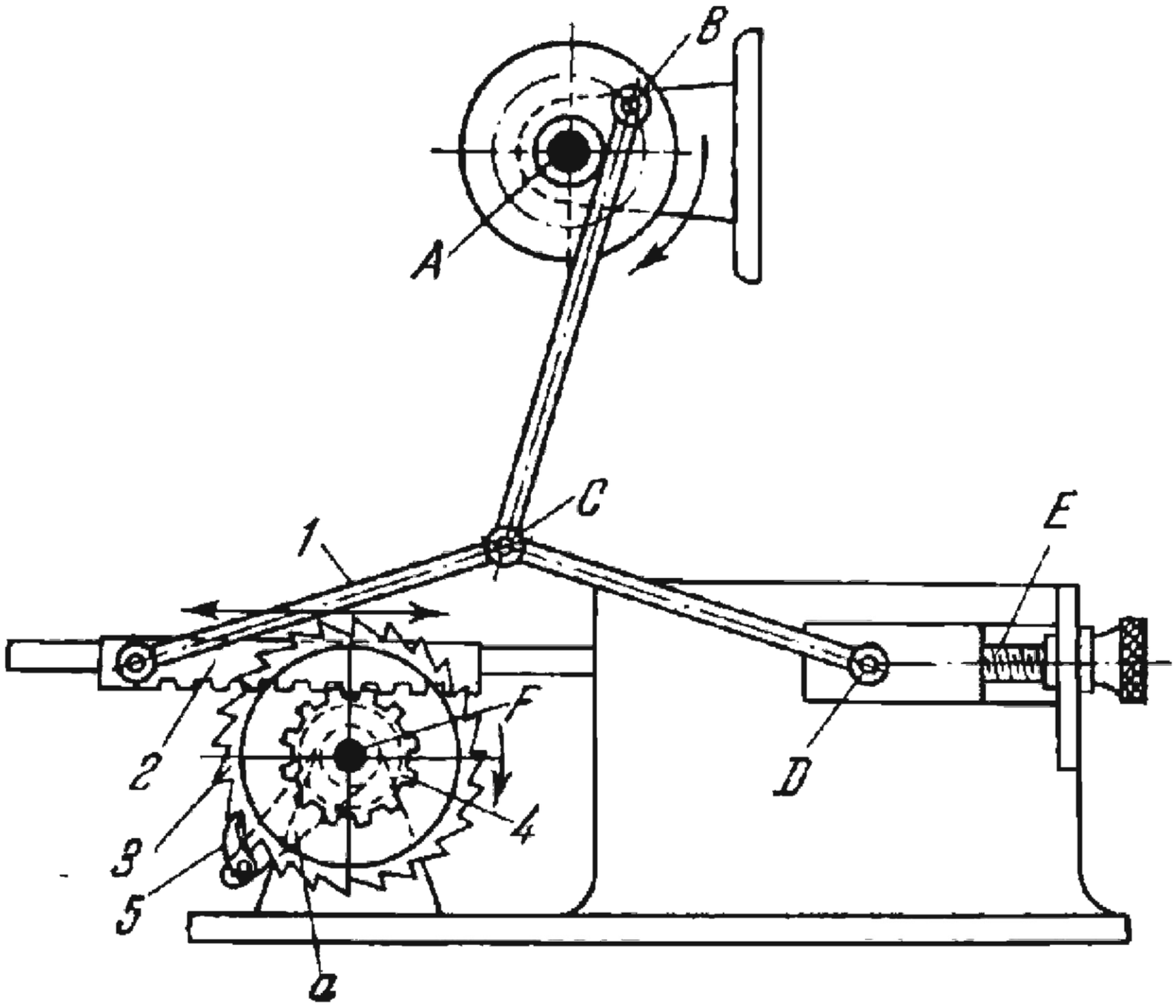
The lengths of the links comply with the conditions: $\overline{AB} = \overline{AD}$ and $\overline{BC} = \overline{DC}$. Slider-crank linkages ABC and ADC, with common slider *1*, are connected by turning pairs B and D to pawls *2* and *4* which engage ratchet wheel *3*. Ratchet wheel *3* rotates about fixed axis A. When slider *1* travels to the right, pawl *2* turns ratchet wheel *3* clockwise; when slider *1* travels to the left, pawl *4* turns wheel *3* in the same direction. In one complete stroke of slider *1* (back and forth), ratchet wheel *3* is turned through the angle $\alpha = 720^\circ/z$, where z is the number of teeth on wheel *3*.

1826	SLIDER-CRANK-DRIVEN LEVER-RATCHET MECHANISM	LR ML



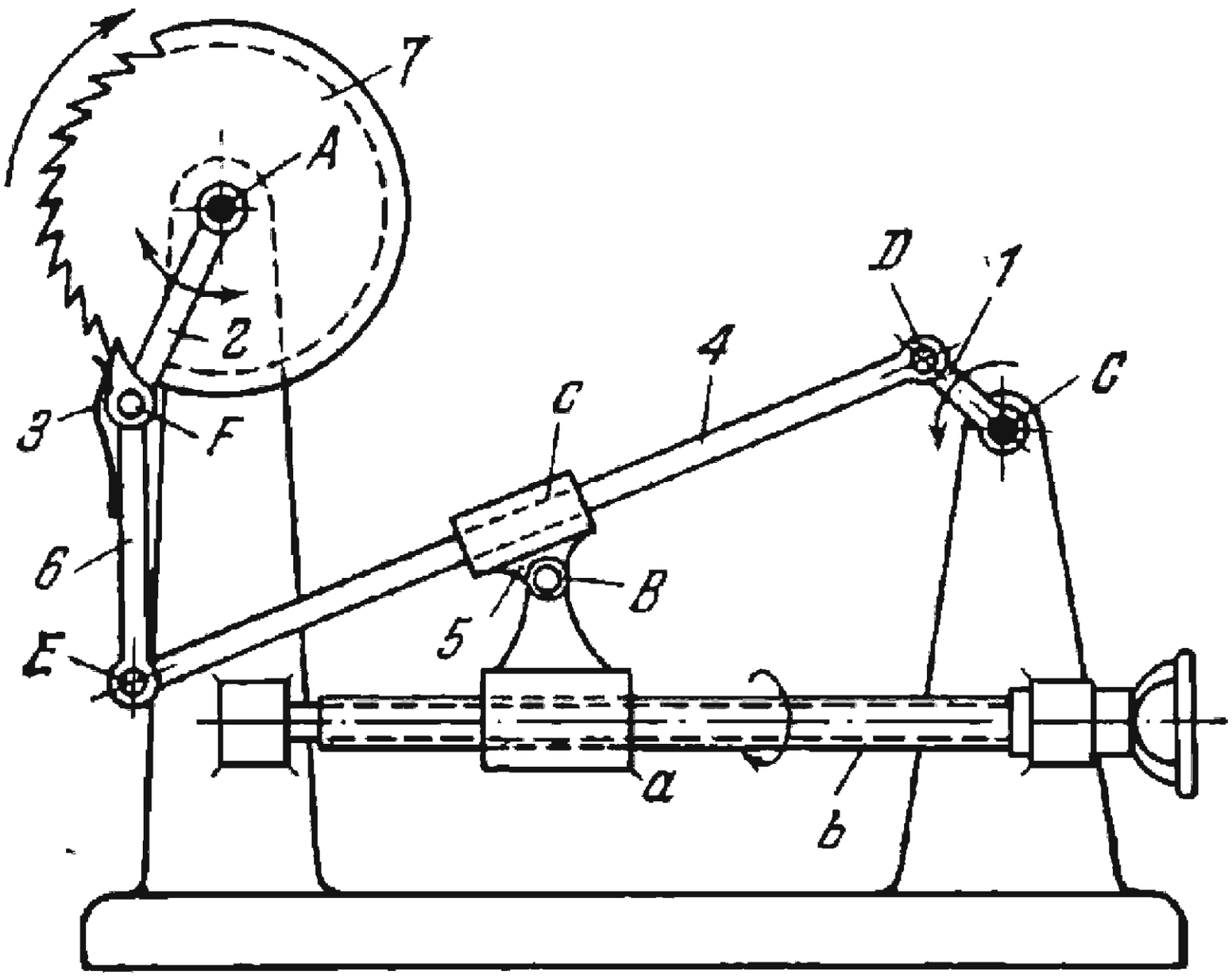
Links *5* and *8* and four-tooth ratchet wheel *4* turn independently of each other about fixed axis *A*. Connecting rods *7* and *6*, of equal length, are connected by turning pairs *C* and *B* to links *5* and *8*, and by turning pairs *F* to slider *1* which moves along fixed guides. Links *5* and *8* are connected by turning pairs *H* and *K* to pawls *2* and *3* which engage teeth *a* of ratchet wheel *4*. Springs *b* hold pawls *2* and *3* against wheel *4*. When slider *1* travels downward, pawl *2* turns ratchet wheel *4* clockwise through 45°; when slider *1* travels upward, pawl *3* turns wheel *4* through another 45° in the same direction. Then the cycle is repeated.

1827	LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE RATCHET WHEEL	LR ML



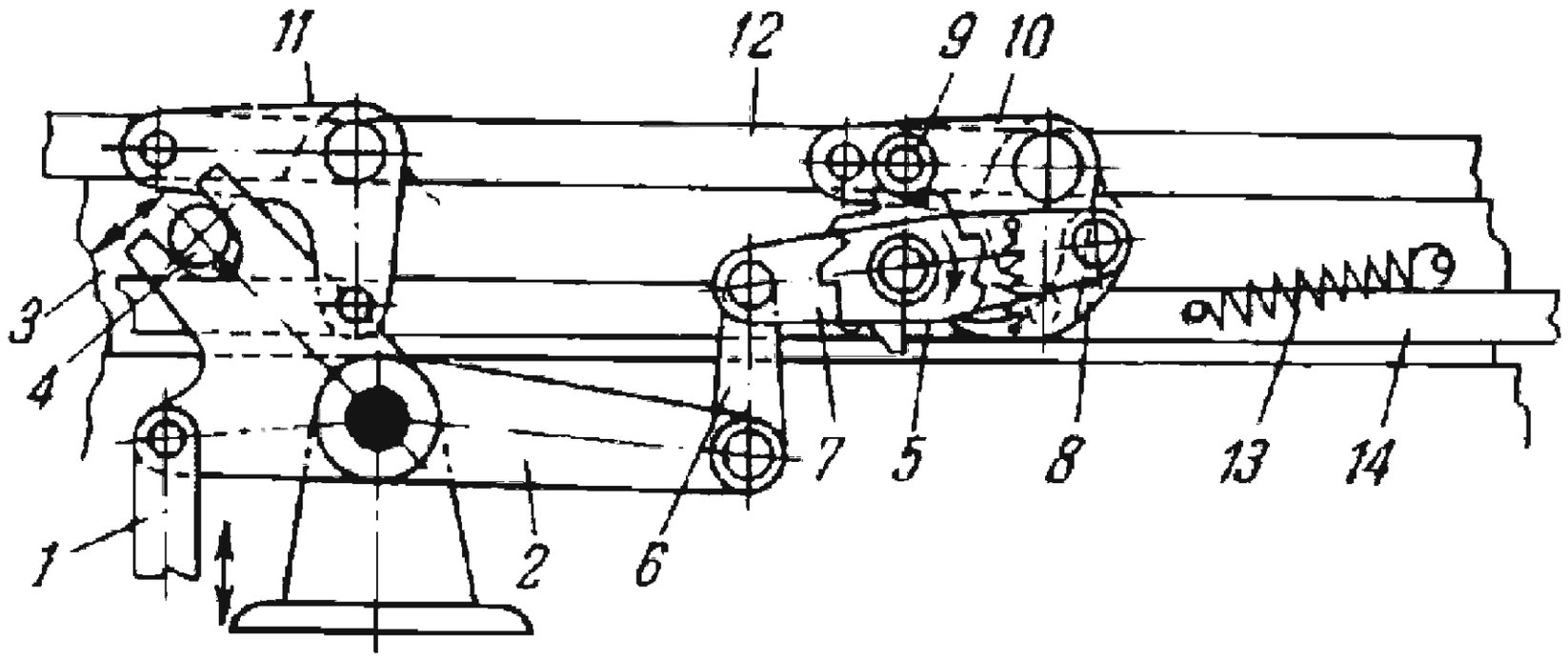
Four-bar linkage *ABCD* is connected by turning pair *C* to link *1* which imparts reciprocating motion to gear rack *2*. The rack stroke can be varied by changing the position of point *D* with screw *E*. Rack *2* meshes with gear *4* which rotates about fixed axis *F*. Rigidly attached to gear *4* is member *a* which is connected by a turning pair to pawl *5*. When rack *2* travels to the right, pawl *5* turns ratchet wheel *3* clockwise about axis *F*, independently of the rotation of gear *4*.

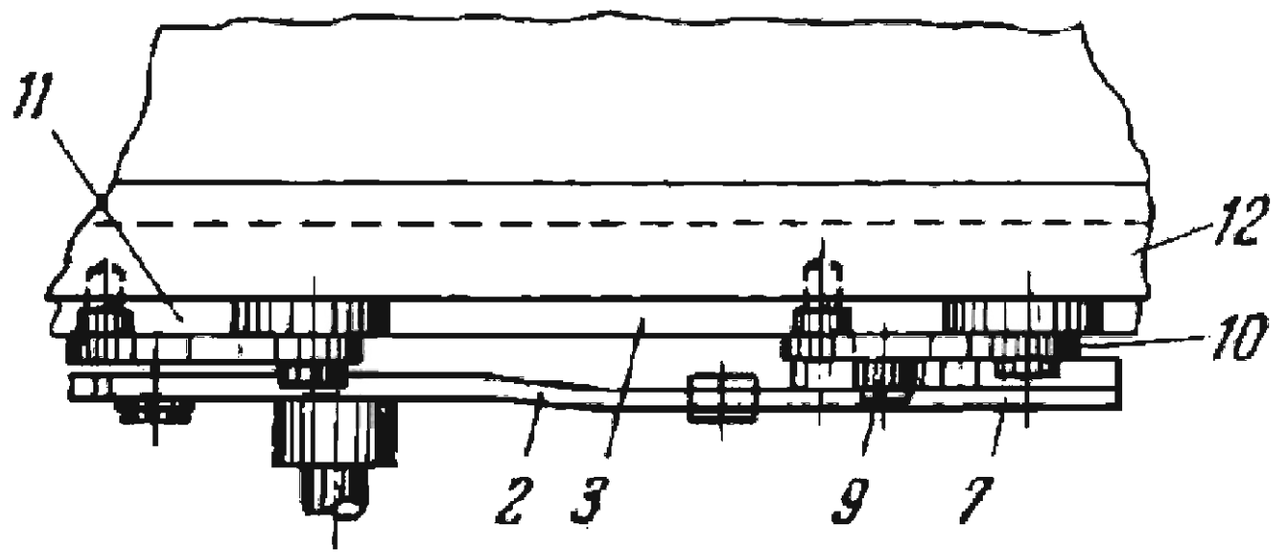
1828	LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE RATCHET WHEEL	LR ML



Ratchet wheel *7* rotates about fixed axis *A*. Crank *1* rotates about fixed axis *C* and is connected by turning pair *D* to link *4* which slides in guide *c* of link *5*. Link *5* turns about axis *B*. Link *4* is connected by turning pair *E* to link *6* which, in turn, is connected by turning pairs *F* to link *2* and to pawl *3* which engages ratchet wheel *7*. Link *2* turns freely about axis *A*. When crank *1* rotates about axis *C*, link-gear mechanism *CDB* oscillates lever *2* about axis *A* and pawl *3* imparts intermittent clockwise motion to ratchet wheel *7*. The angular velocity (and angle of rotation) of wheel *7* can be varied by changing the position of point *B* by means of screw *b* and nut *a*, and clamping them in the required position.

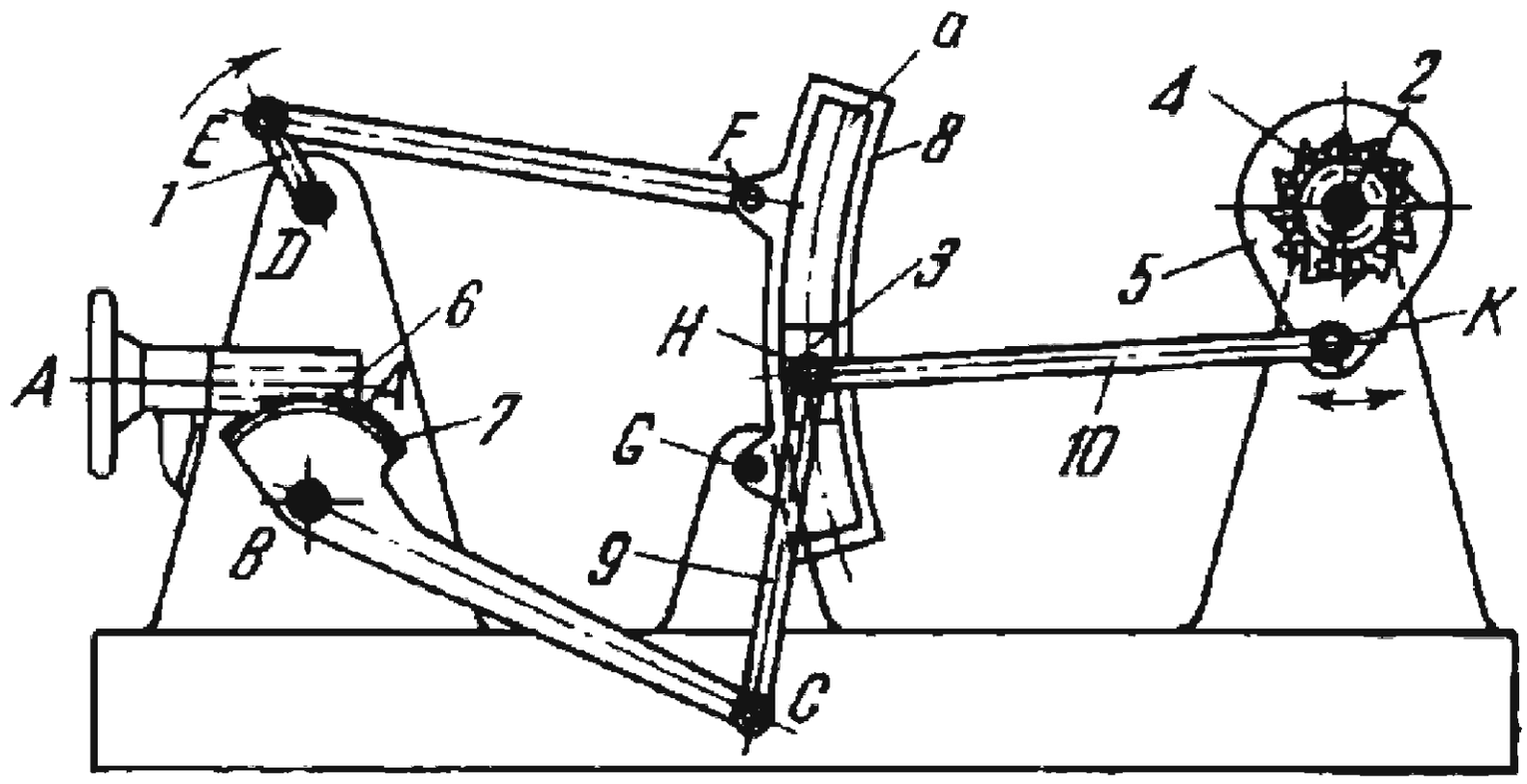
LEVER-RATCHET MECHANISM WITH A DOUBLE PARALLEL-CRANK LINKAGE





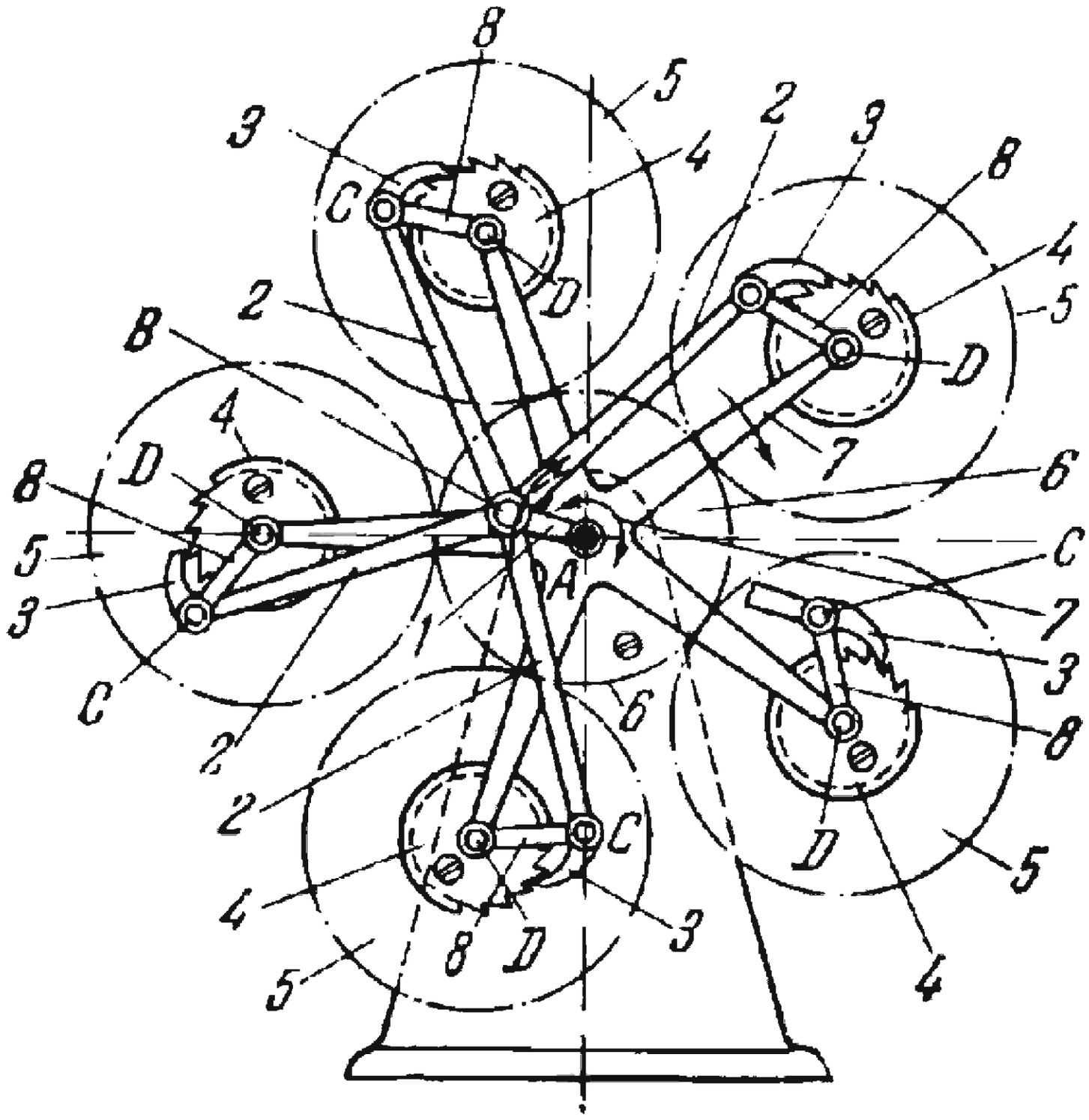
Frame *3*, resting on a fixed bed, is connected to it by several links. One of these links, *2*, serves to drive the mechanism from link *1* which is actuated by a cam (not shown). Motion is transmitted simultaneously from the forked arm of link *2* to frame *3* by roller *4*, mounted on the frame, and from another arm of link *2*, through links *6* and *7* and pawl *8* to ratchet wheel *5* which is mounted on a stud secured in frame *3*. Mounted on frame *3* are several bellcranks *11* and one bellcrank *10* which carries roller *9*. Bellcranks *11* and *10* are connected by turning pairs to frame *12* and strip *14*. When link *1* moves upward, links *3*, *12* and *14* have translational motion and pawl *8* slides over the teeth of ratchet wheel *5*. When link *1* moves downward, ratchet wheel *5* is turned clockwise so that a tooth raises roller *9*, turning bellcranks *11* and *10* about their axes and imparting supplementary motion to frame *12*. Spring *13* returns frame *12* to its initial position at the end of the down stroke of link *1*.

1830	LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE DRIVEN LINK	LR ML



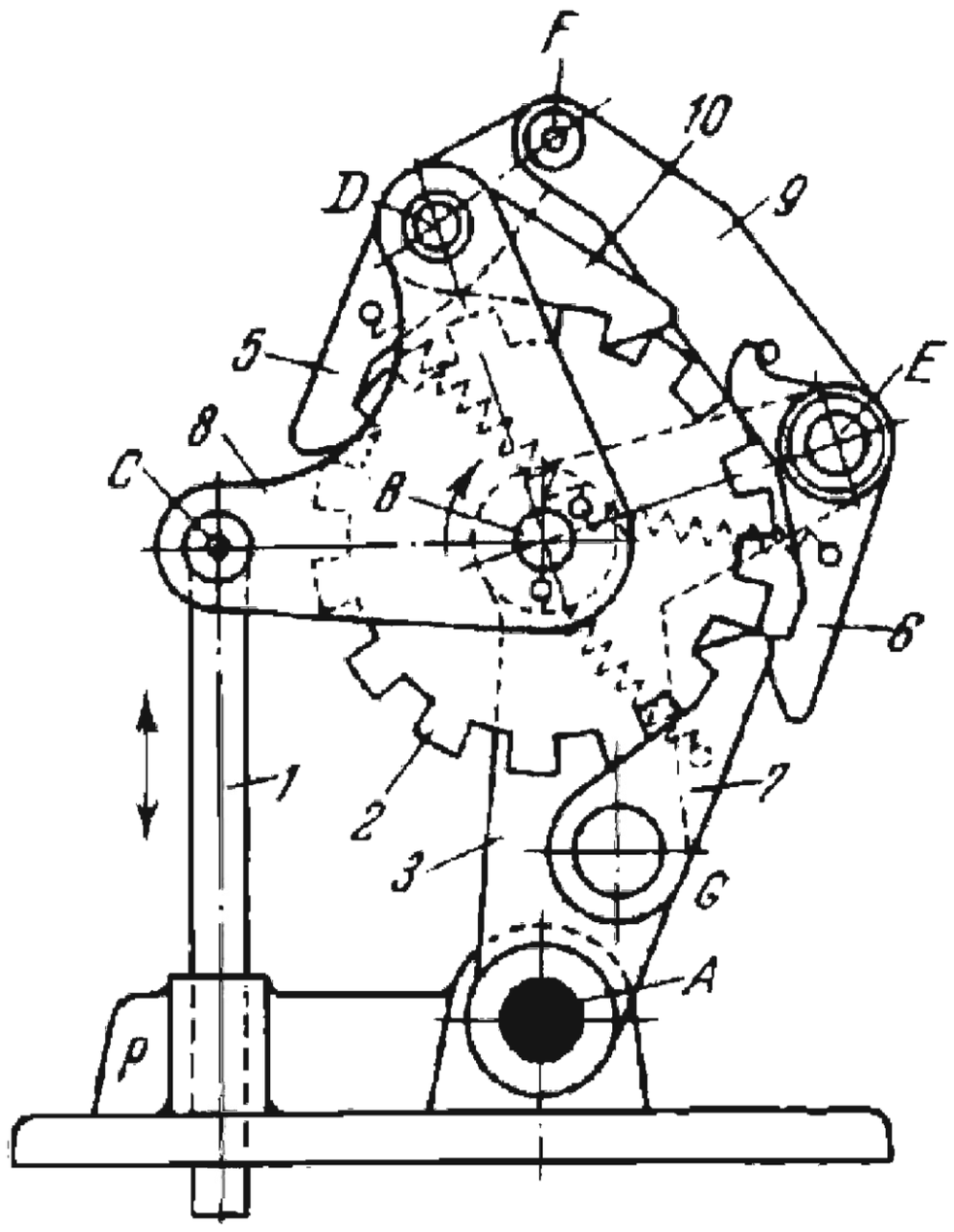
Rocker arm *8* of four-bar linkage *DEFG* is designed as a slotted link with a circular slot in which slider *3* moves. Worm *6* rotates about fixed axis *A-A* and turns worm wheel segment *7* about fixed axis *B*. This changes the position of point *C* of link *9*, and thereby changes the stroke of slider *3* in slot *a*. Link *10* is connected by turning pairs *H* and *K* to slider *3* and to link *5* which is designed as a housing with internal wedge-shaped recesses containing balls *4*. When crank *1* rotates about fixed axis *D*, intermittent clockwise rotation is transmitted to link *2* by means of an overrunning clutch consisting of balls *4* and housing *5*. The angular velocity of this motion can be varied by turning worm *6*.

1831	LEVER-RATCHET PLANETARY MECHANISM	LR ML



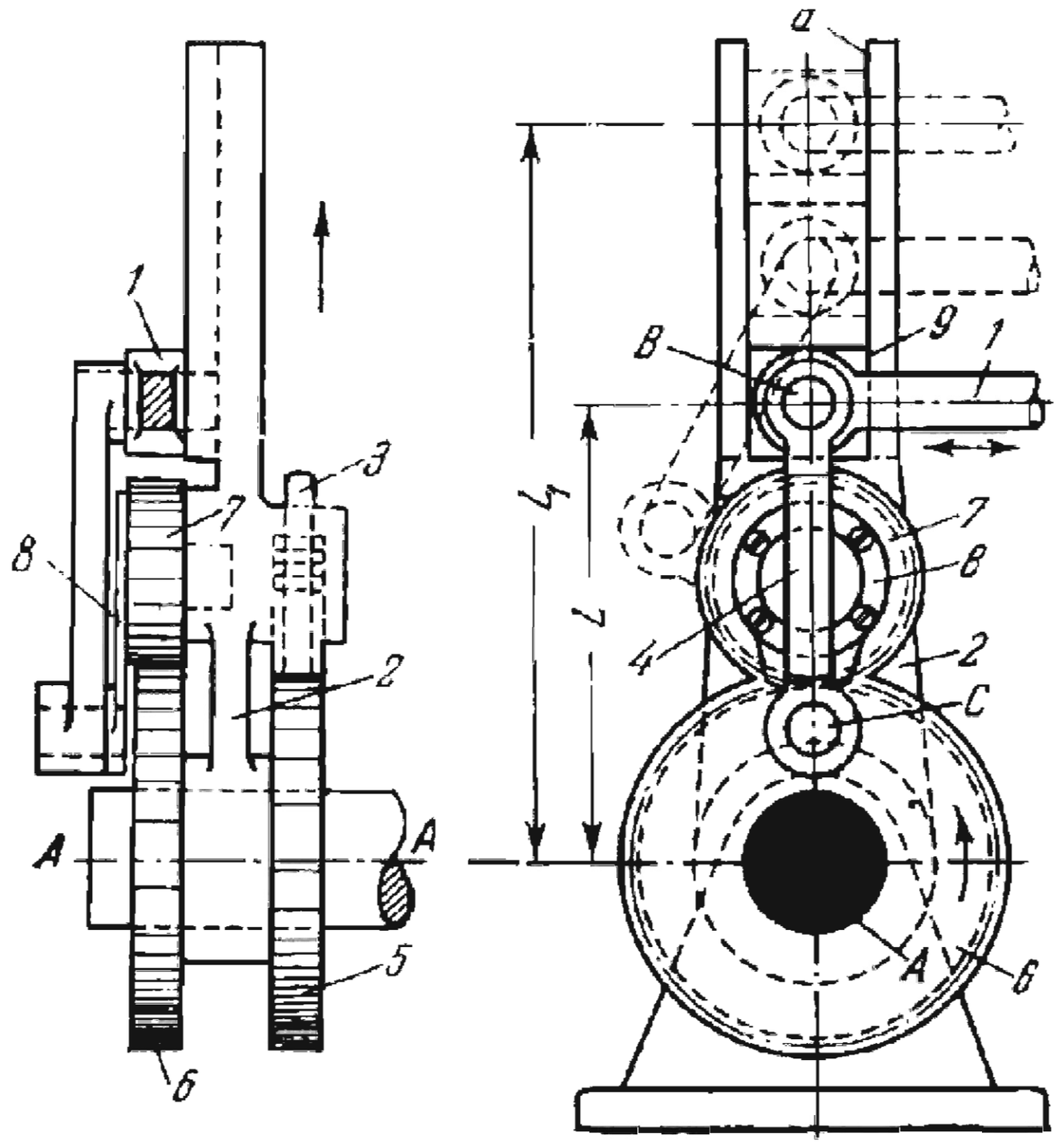
Crank *1* rotates about fixed axis *A* and is connected by turning pairs *B* to links *2*. Links *8* are connected by turning pairs *C* and *D* to links *2* and to ratchet wheels *4* which are rigidly fastened to gears *5*. Gears *5* mesh with fixed gear *6* and are connected by turning pairs *D* to link *7* which rotates about axis *A*. The sum of the radii of gears *5* and *6* is $R_5 + R_6 = \overline{AD}$. Pawls *3* are connected by turning pairs *C* to links *8* and engage ratchet wheels *4*. When crank *1* rotates about axis *A*, pawls *3* turn ratchet wheels *4* and gears *5*. Gears *5* roll around gear *6* and thereby rotate link *7* intermittently clockwise.

1832	SLIDER-CRANK-DRIVEN LEVER-RATCHET MECHANISM	LR ML



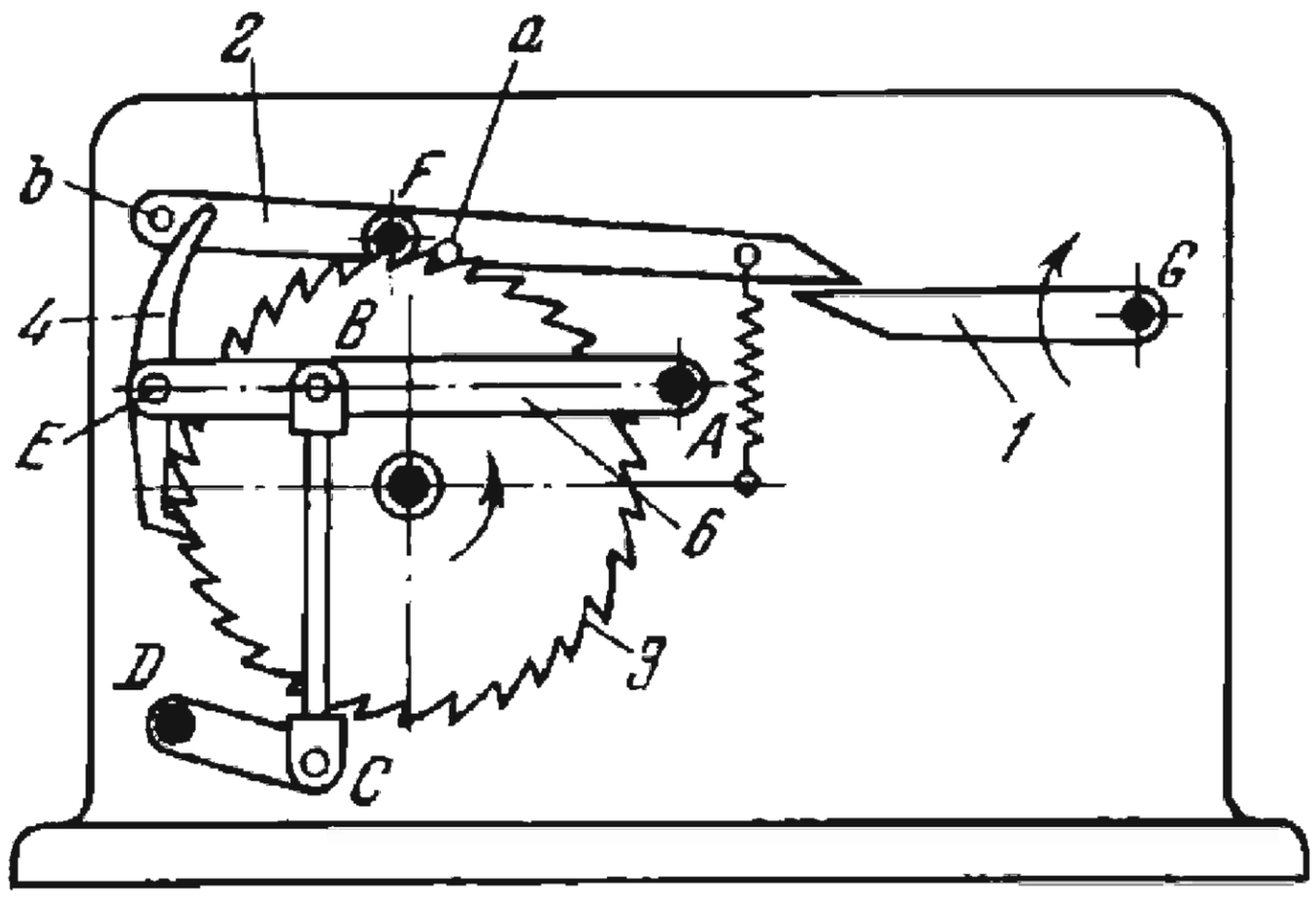
Rod *1* reciprocates in fixed guide *p* and is connected by turning pair *C* to bellcrank *8*. Lever *3* turns about fixed axis *A* and is connected by turning pair *B* to link *8*. Links *8* and *3* are connected by turning pairs *D* and *E* to links *5* and *9* which are connected together by turning pair *F*. Link *5* is designed as a pawl which engages ratchet wheel *2*. Pawls *10*, *6* and *7* turn freely about axes *D*, *E* and *G* of links *5* and *3*. Pawls *5*, *6* and *7* are held by springs, secured to link *8*, against ratchet wheel *2*. When rod *1* reciprocates, pawls *5* and *6* turn ratchet wheel *2* intermittently clockwise about axis *B*. Pawls *7* and *10* prevent rotation of the ratchet wheel during the return stroke of rod *1*.

1833	LEVER-RATCHET MECHANISM WITH VARIABLE ANGULAR VELOCITY OF THE RATCHET WHEEL	LR ML



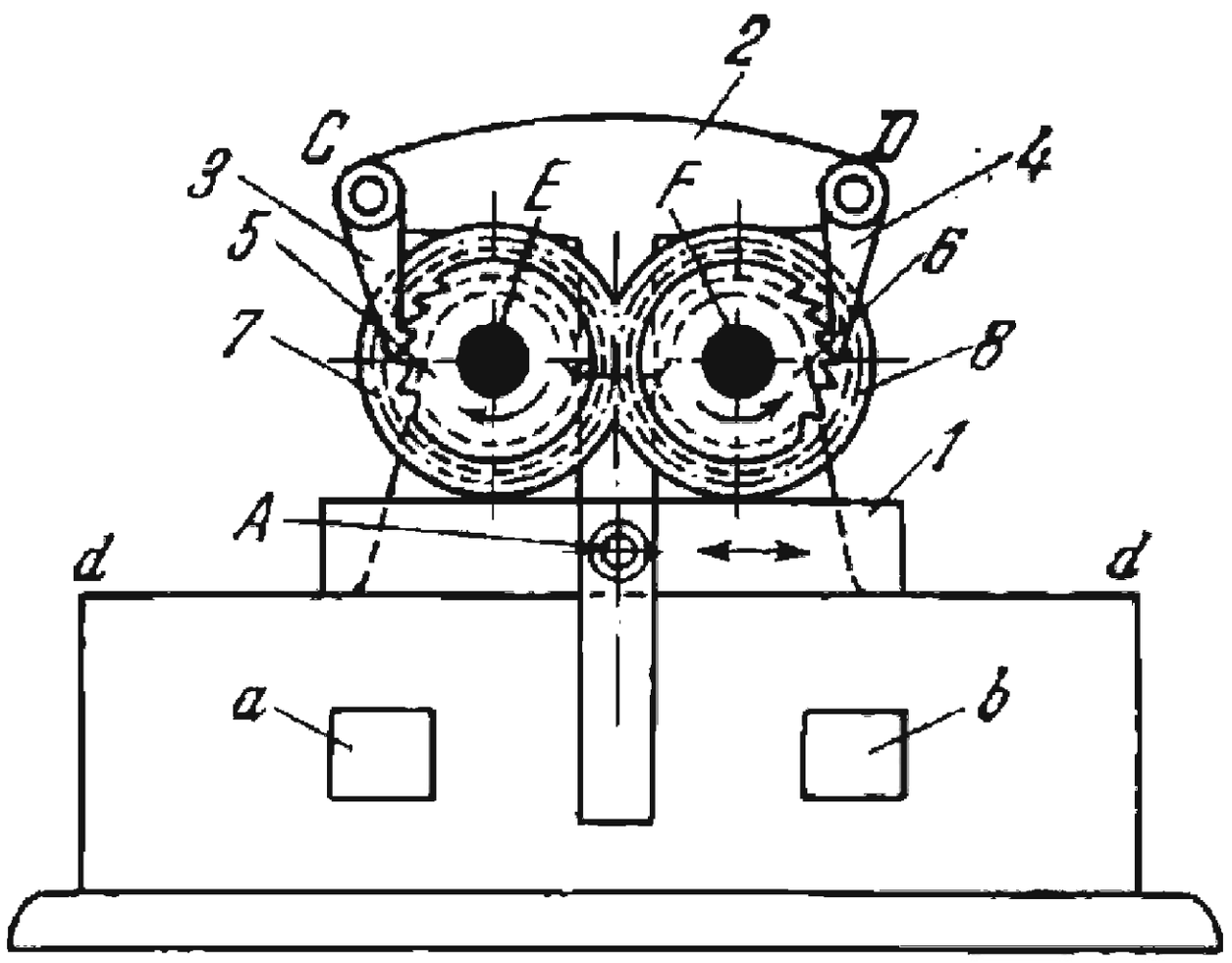
Slider *9* moves along slot *a* of lever *2* which turns about fixed axis *A*. Slider *9* is connected by turning pair *B* to rod *1*. Link *4* is connected by turning pairs *B* and *C* to slider *9* and lever *8* which is rigidly attached to pinion *7*. Pinion *7* meshes with gear *6*. Lever *2* carries pawl *3*, shown schematically, engaging ratchet wheel *5*, which is rigidly attached to gear *6*, both being keyed on shaft *A*. When rod *1* moves to the left, pawl *3* turns ratchet wheel *5* and the whole assembly counterclockwise. On the return stroke of rod *1*, pawl *3* slides over the teeth of ratchet wheel *5* while shaft *A* with gear *6* remain stationary. This causes pinion *7* to revolve about gear *6*, turning lever *8* to the position shown by dash lines. At this link *4* pushes slider *9* upward, increasing the distance $\overline{AB}$. Thus the length of the lever arm is varied from L to L_1, increasing and decreasing the amplitude of oscillation of lever *2* and thereby varying the angular velocity of ratchet wheel *5* and gear *6*. The number of cycles of velocity variation per revolution of gear *6* depends on the gearing ratio between gears *6* and *7*.

1834	LINKWORK-DRIVEN LEVER-RATCHET MECHANISM	LR ML



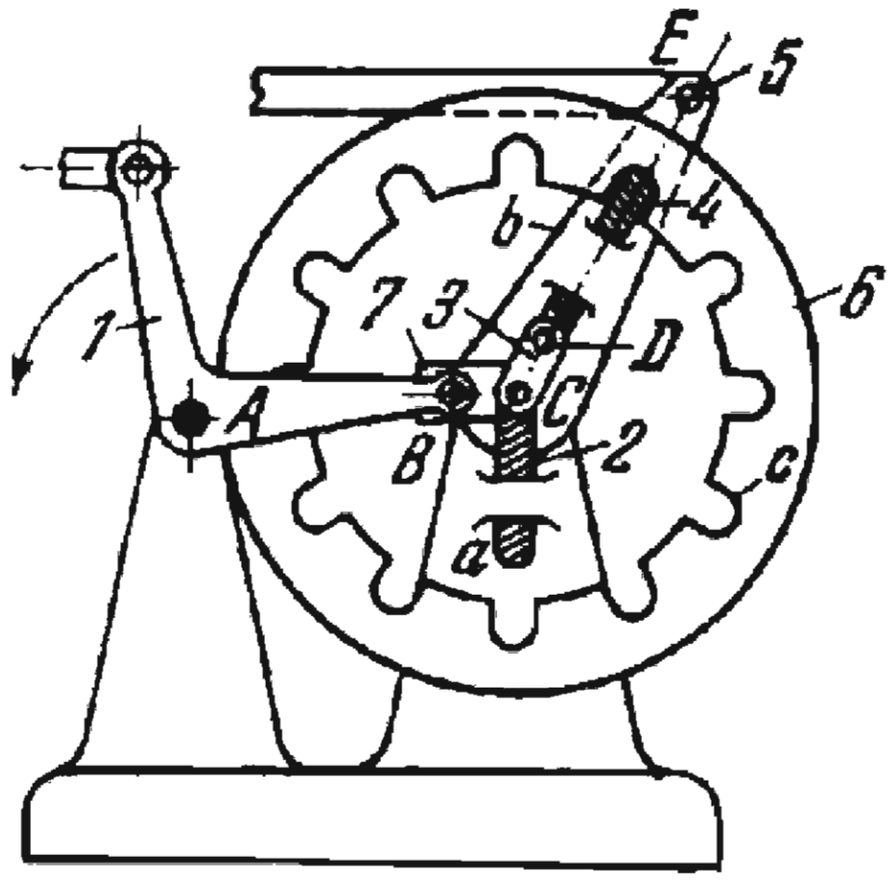
Rocker arm *6* of four-bar linkage *DCBA* turns about fixed axis *A* and is connected by turning pair *E* to pawl *4*. Levers *1* and *2* turn about fixed axes *G* and *F*. Lever *2* has pins *a* and *b*. Pawl *4* engages ratchet wheel *3*, turning it intermittently counterclockwise. Pin *a* on lever *2* prevents reverse rotation of ratchet wheel *3*. When lever *1* is turned clockwise, pin *a* is disengaged from wheel *3* and pin *b* turns pawl *4* also disengaging it from ratchet wheel *3*.

1835	LEVER-RATCHET PERIODIC-DWELL MECHANISM	LR D



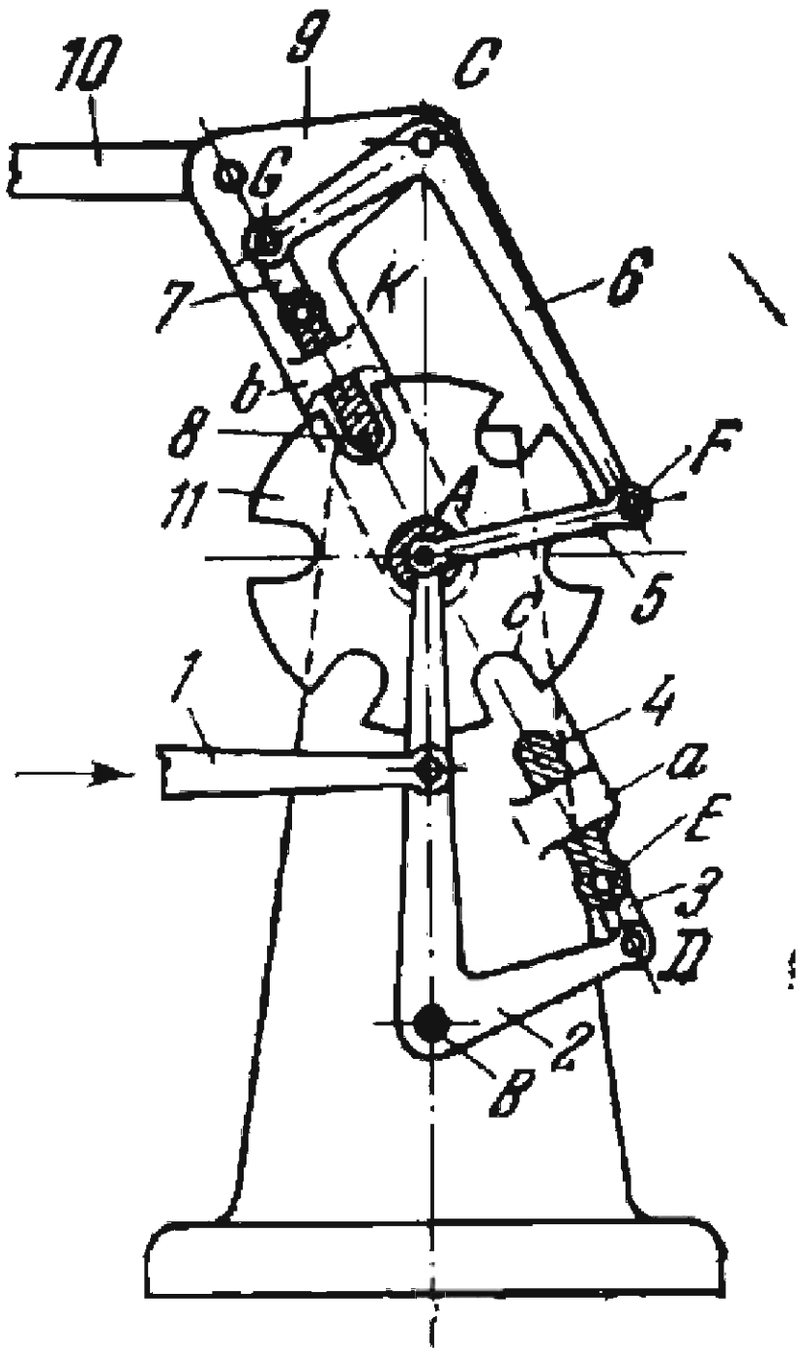
Slider *1* moves along fixed plane *d-d*. Link *2* is connected by turning pair *A* to slider *1* and by turning pairs *C* and *D* to pawls *3* and *4* which engage ratchet wheels *5* and *6*. Wheels *5* and *6* are rigidly attached to meshing gears *7* and *8* which rotate about fixed axes *E* and *F*. When slider *1* reciprocates, lever *2*, at the end of each stroke, runs against lug *a* or *b* so that it alternately turns from side to side, bringing either pawl *4* or *3* into engagement with ratchet wheel *6* or *5*. This turns gears *7* and *8* with periodic dwells.

1836	LEVER-RATCHET ENGAGING AND DISENGAGING MECHANISM	LR SE



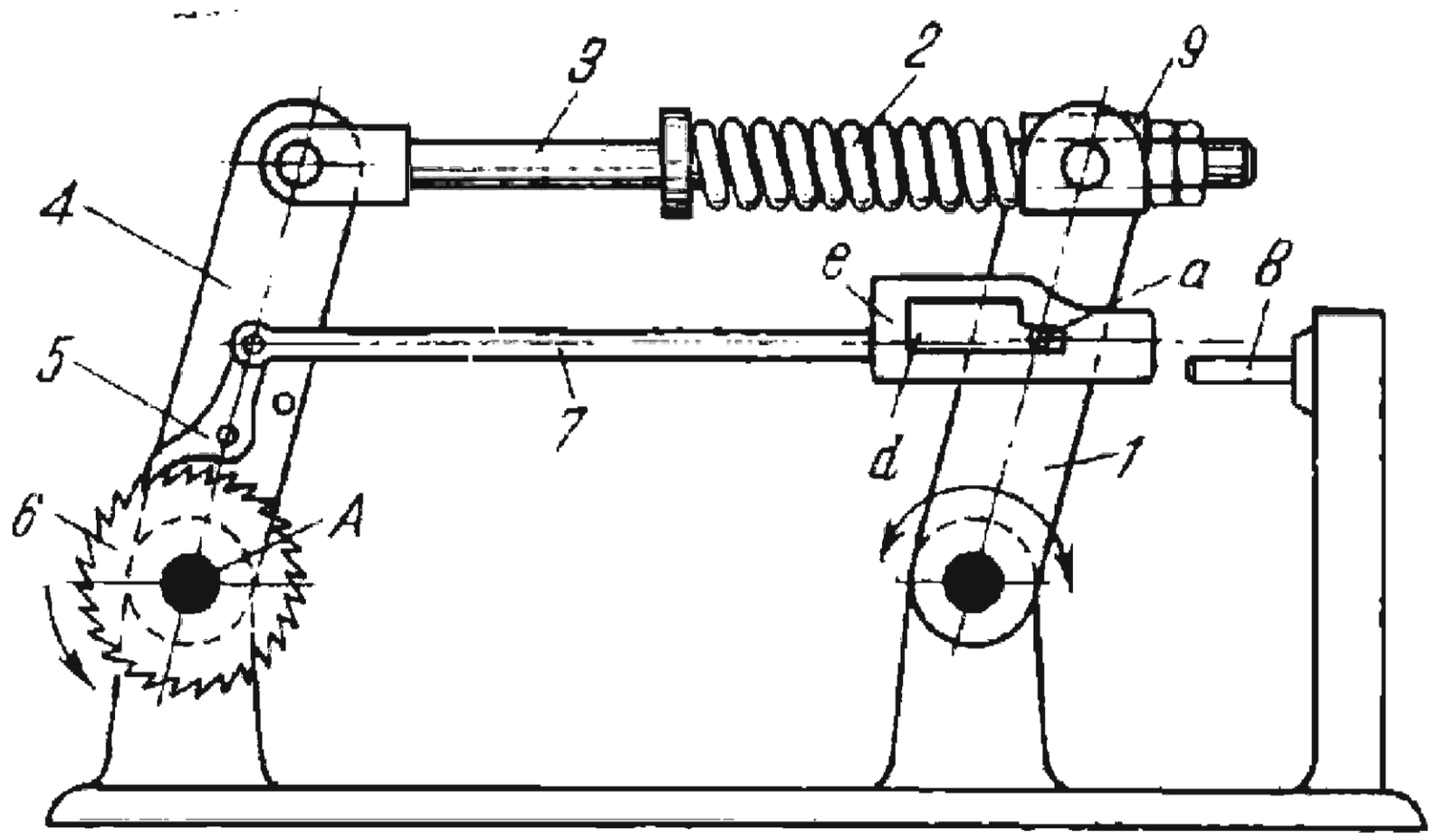
Link *7* is connected by turning pair *B* to bellcrank *1* and by turning pair *C* to latch *2* which slides in fixed guide *a*. Links *2* and *7* are connected by turning pair *C* to link *3* which, in turn, is connected by turning pair *D* to latch *4*, sliding in guide *b* of link *5*. Link *5* and wheel *6*, having slots *c*, turn independently of each other about a fixed axis (not indicated). When latch *2* enters a slot *c* of wheel *6*, the wheel is held stationary. When bellcrank *1* is turned counterclockwise, latch *2* is withdrawn from engagement with wheel *6* and, by means of link *3*, latch *4* simultaneously enters another slot of the wheel. At this, point *C* coincides with the axis of rotation of wheel *6* and link *5*. Link *5* then turns wheel *6* about its axis through the required angle. After this, bellcrank *1* is turned clockwise to withdraw latch *4* from engagement with wheel *6*. Simultaneously, latch *2* is inserted into the corresponding slot *c* and locks wheel *6*.

LINKWORK LEVER-RATCHET ENGAGING AND DISENGAGING MECHANISM



Bellcrank *2* turns about fixed axis *B* and is connected by turning pair *D* to link *3* which, in turn, is connected by turning pair *E* to latch *4* sliding in fixed guide *a*. Link *5* is connected by turning pairs *A* and *F* to bellcrank *2* and to bellcrank *6* which turns about axis *C* on link *9*. Bellcrank *6* is connected by turning pair *G* to link *7* which, in turn, is connected by turning pair *K* to latch *8* sliding in guide *b* of link *9*. Link *9* and disk *11*, having slots *c*, turn independently of each other about a fixed axis (not indicated). When link *1* moves to the right, bellcrank *2* and link *3* withdraw latch *4* from engagement with disk *11* and, by means of link *5* and bellcrank *6*, latch *8* enters another slot of disk *11*. At this, point *A* coincides with the axis of rotation of disk *11* and link *9*. Then links *5*, *6*, *7*, *8* and *9* form a single assembly with disk *11*, and motion of tie-rod *10* turns disk *11* about its axis. When link *1* is moved to the left, latch *8* is withdrawn from disk *11* and latch *4* is inserted into the corresponding slot *c* and locks disk *11*.

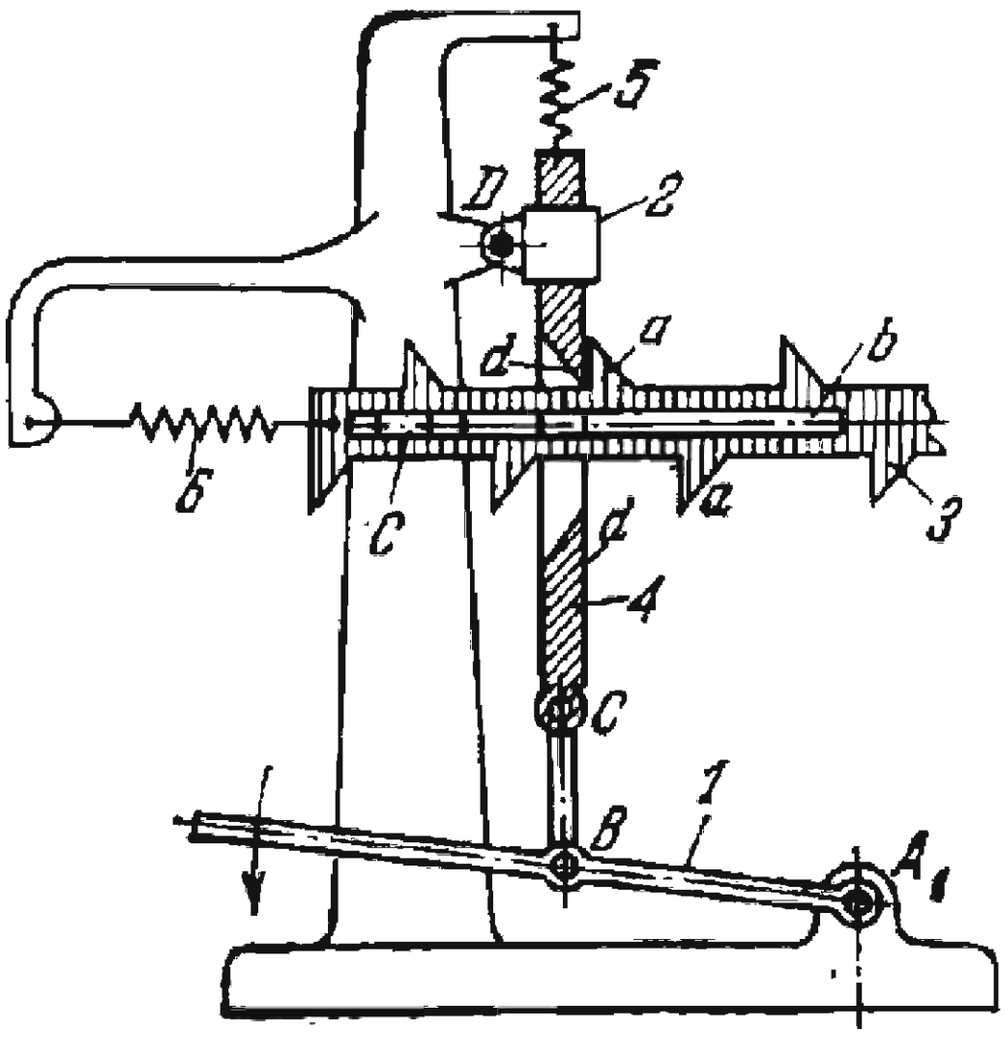
1838	LEVER-RATCHET TRIPPING (OVERLOAD RELIEF) MECHANISM	LR SE



Shaft *A* is rotated intermittently by ratchet wheel *6* and pawl *5* which is carried by lever *4*. Lever *4* is oscillated by lever *1* through connecting rod *3*. At the end of lever *1* is swinging yoke *9* through which rod *3* passes. Rod *3* carries spring *2* which is compressed when the load on shaft *A* exceeds a predetermined limit. Pawl *5* is connected to plate *e* by connecting rod *7*. Plate *e* has irregular slot *d* and rests on pin *a* of lever *1*. Under normal load conditions of shaft *A*, rod *7* carries no load, merely riding between levers *4* and *1*. When shaft *A* is stopped by an overload, the continued motion of lever *1* to the left compresses spring *2* and pin *a* is carried to the wider portion of slot *d* so that plate *e* and rod *7* drop downward slightly and, when lever *1* swings to the right, pin *a* engages the shoulder in slot *d*. This pulls rod *7* to the right, disengaging pawl *5* from ratchet wheel *6* and enabling plate *e* to contact electric switch *8* and stop the machine. When plate *e* is lifted and disengaged from pin *a*, the machine is ready to start again if the overload on shaft *A* has been eliminated.

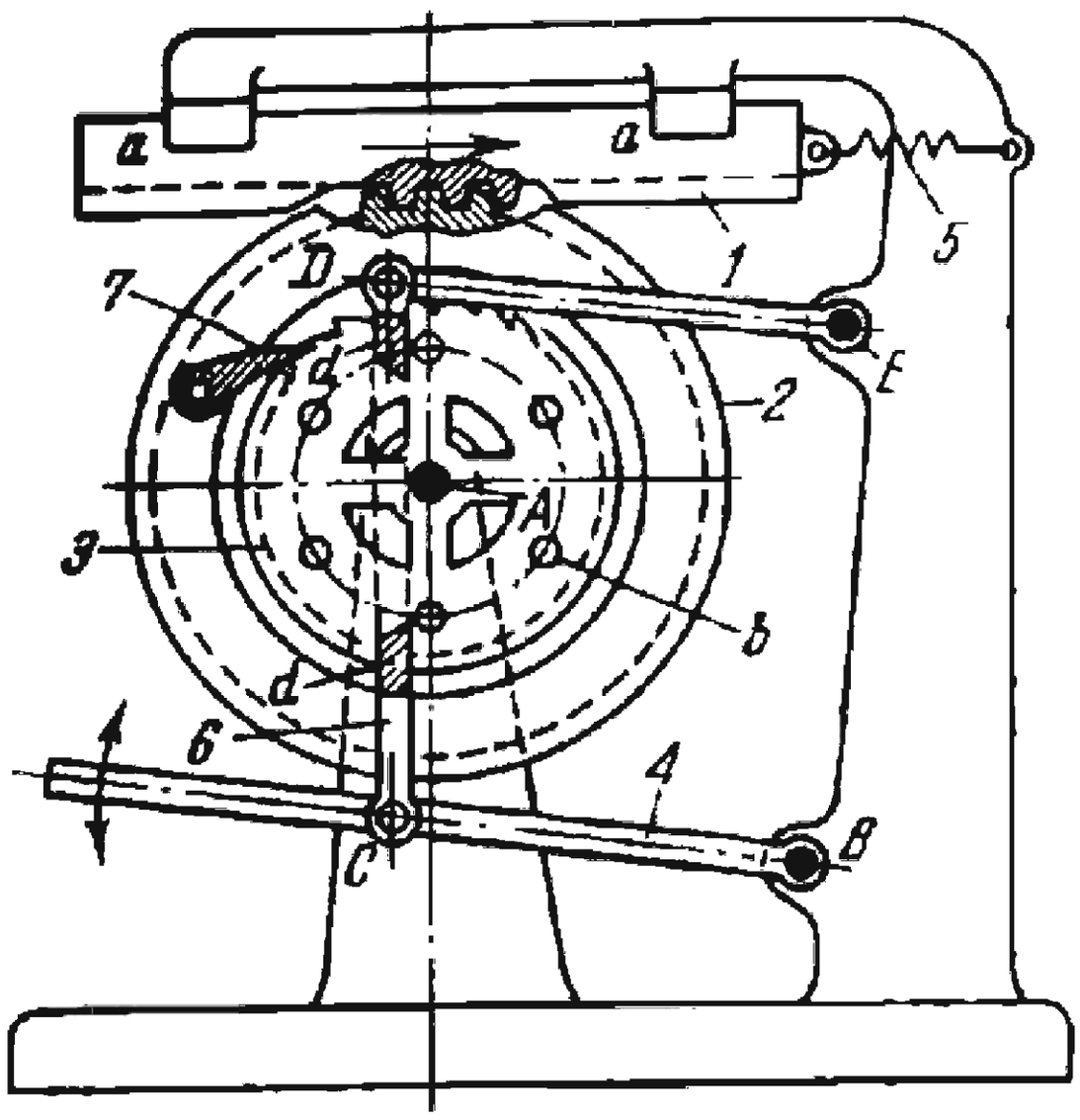
7. STOP, DETENT AND LOCKING MECHANISMS (1839, 1840 and 1841)

1839	LEVER-RATCHET STOP MECHANISM	LR SD

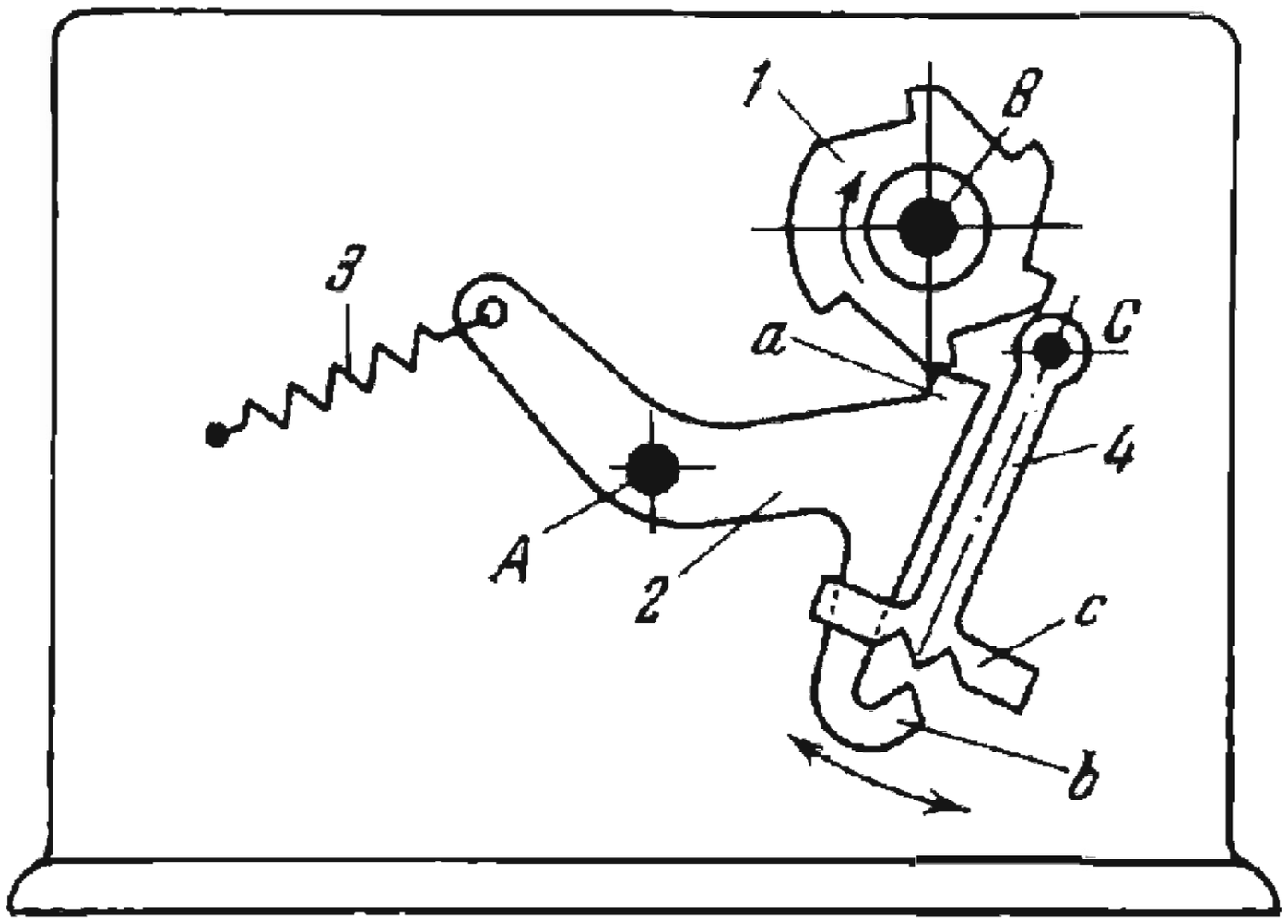


Link *3* has projections *a* and slot *b* which slides along fixed block *C*. The motion of link *3* is due to the action of spring *6*. Slider *4* of linkage *ABD* moves in guide *2* and has lugs *d*. Link *3* is stopped when a lug *d* engages a projection *a*. When lever *1* is turned counterclockwise, the upper projections *a* of link *3* are engaged. The lower projections are engaged when slider *4* is pulled upward by spring *5*. Guide *2* has a certain degree of freedom about fixed axis *D*. This avoids impacts in the engagements of projections *a* and lugs *d*.

1840	LEVER-RATCHET ESCAPEMENT MECHANISM	LR SD

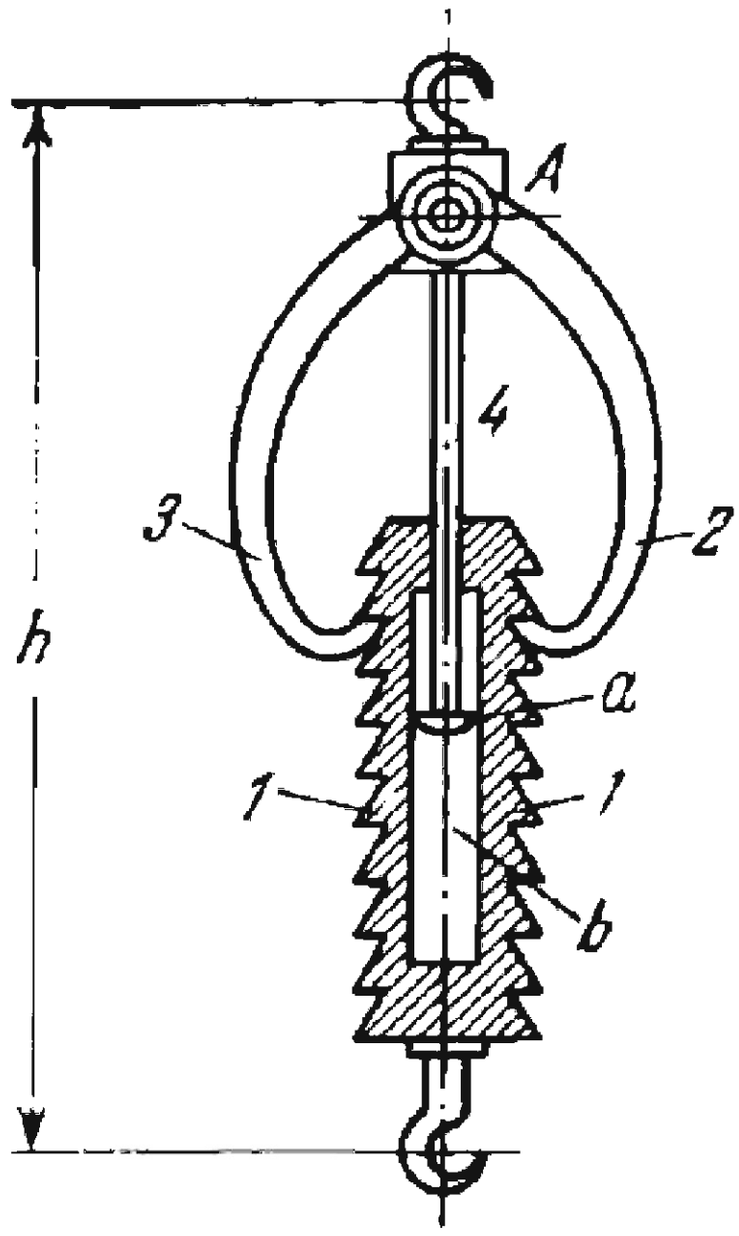


Gear rack *1* is moved to the right in guides *a-a* by spring *5*. Rack *1* meshes with gear *2* which it turns clockwise about fixed axis *A*. Gear *2* is connected by pawl *7* to ratchet wheel *3*. Ratchet wheel *3* has pins *b* that are engaged by lugs *d* of connecting rod *6* of the linkage *BCDE*. When lever *4* is oscillated, ratchet wheel *8* is stopped intermittently when lugs *d* engage pins *b*.



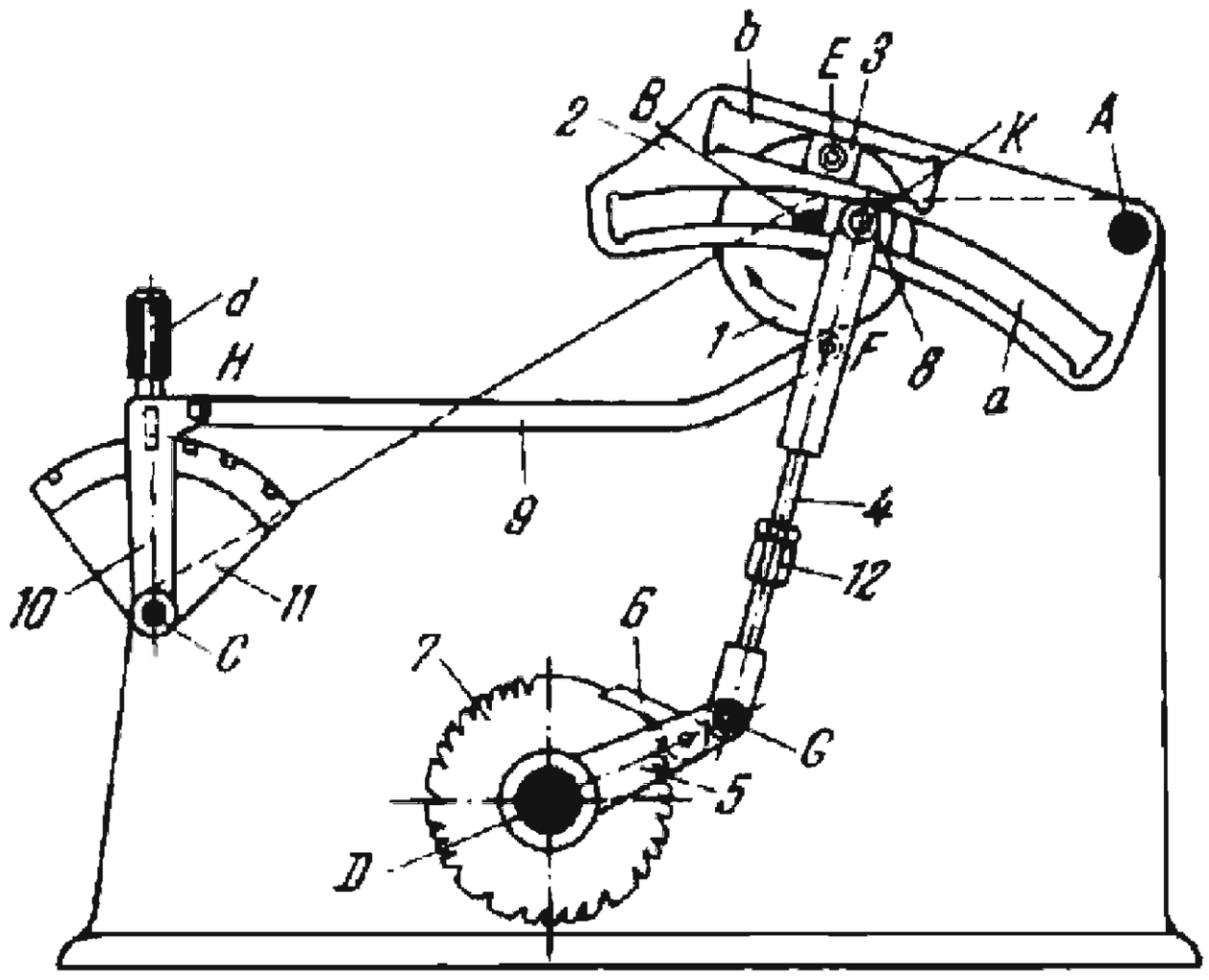
Ratchet wheel *1* rotates about fixed axis *B*. Lever *2* is a pawl having two teeth, *a* and *b*, and turns about fixed axis *A*. Lever *4* with notches *c* turns about fixed axis *C*. When ratchet wheel *1* turns clockwise, tooth *a* of lever *2*, held against the wheel by spring *3*, enters a tooth space of the ratchet wheel. Lever *2* turns counterclockwise about axis *A* and tooth *b* enters a notch *c* on oscillating lever *4* and stops the lever. Upon further rotation of ratchet wheel *1*, tooth *a* is pushed outward by the next tooth on wheel *1*, and tooth *b* is withdrawn from the notch on lever *4* thereby releasing the lever.

1842	LEVER-RATCHET RACK-TYPE DEVICE FOR CONTROLLING THE HEIGHT OF LOAD SUSPENSION	LR MH



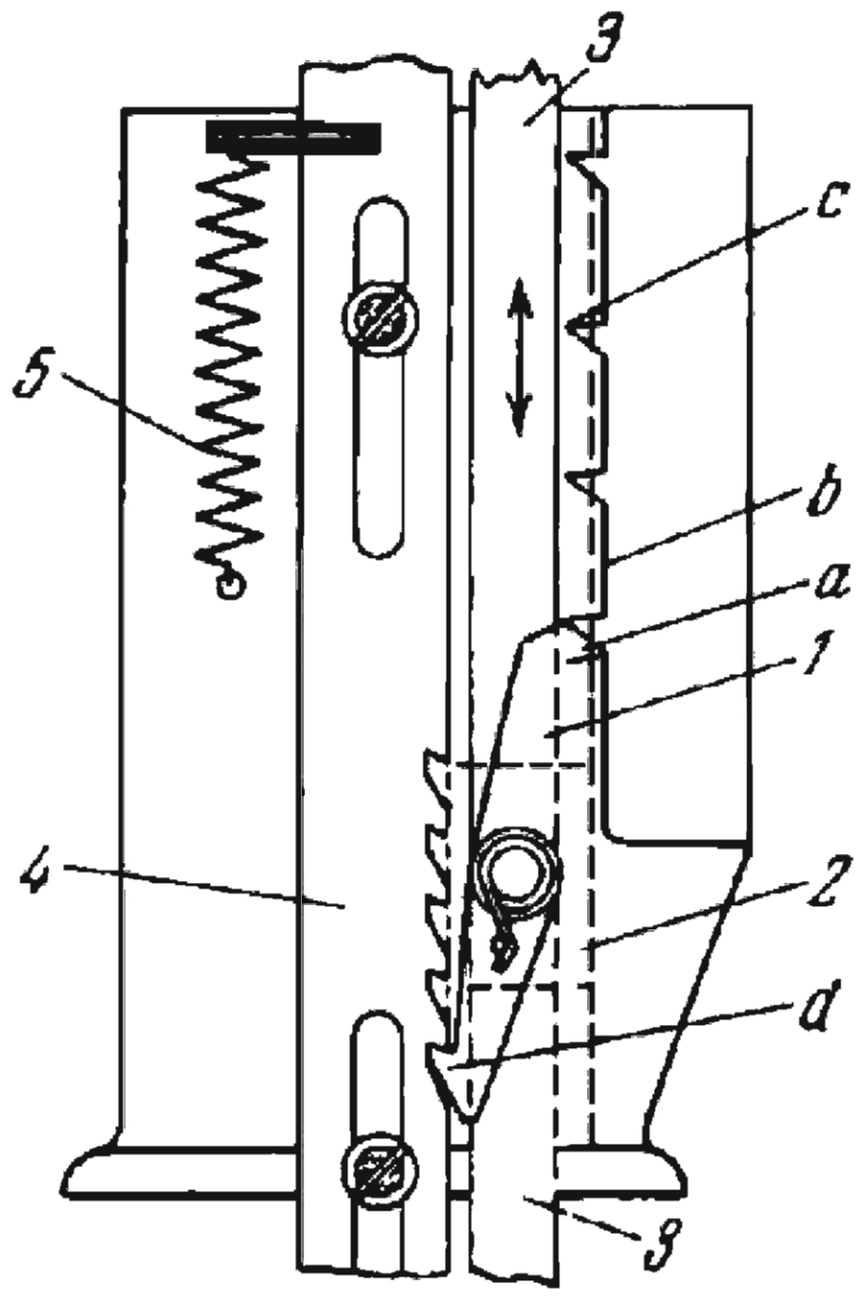
Pawls *2* and *3* turn about axis *A*. Rod *4* ends in head *a* which slides along guide *b*. The distance *h* between the hooks is varied by engaging ratchet-tooth rack *1* at various positions along its height by pawls *2* and *3*.

1843	LEVER-RATCHET INTERMITTENT FEED MECHANISM	LR SF



Crank *1* rotates about fixed axis *B* and is connected by turning pair *E* to slider *3* which moves along slot *b* of slotted link *2*. Link *2* turns about fixed axis *A*. Link *4* is connected by turning pairs *K*, *F* and *G* to slider *8* and links *9* and *5*. Slider *8* moves along circular slot *a* of link *2*. Link *5* turns about fixed axis *D* and carries pivoted pawl *6* which engages ratchet wheel *7*. When crank *1* rotates clockwise, slotted link *2* oscillates. This motion is transmitted to pawl *6* which turns ratchet wheel *7* intermittently counterclockwise about axis *D*. The angle of rotation of wheel *7* depends upon the position of point *H* which is changed by turning lever *10*. Lever *10* is set in the required position by turning it with handle *d* about fixed axis *C* and locking it in this position by having the pin on handle *d* enter the corresponding slot of fixed quadrant *11*.

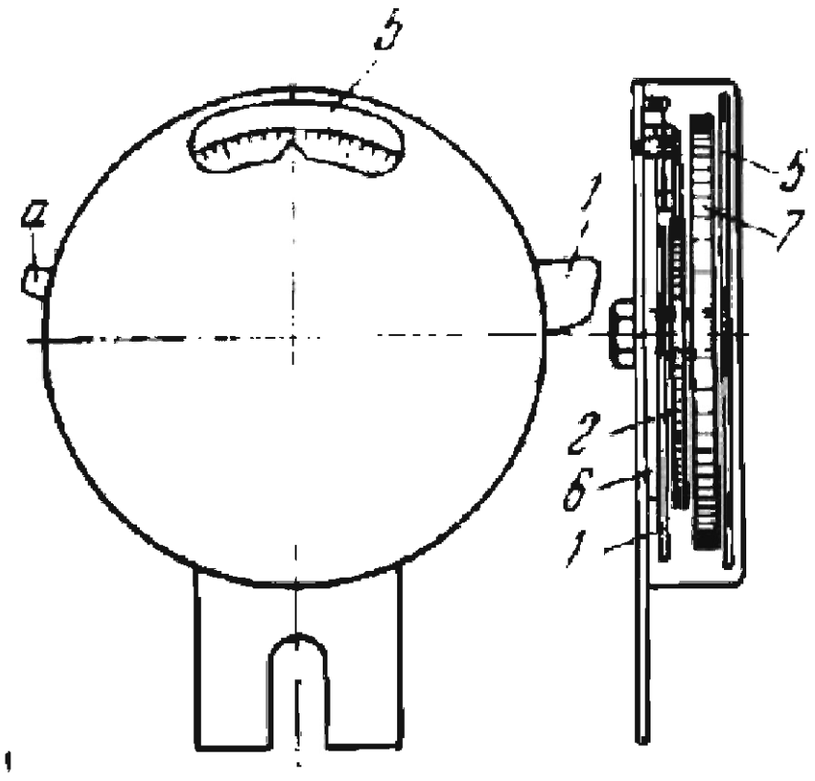
1844	LEVER-RATCHET INTERMITTENT FEED MECHANISM	LR SF

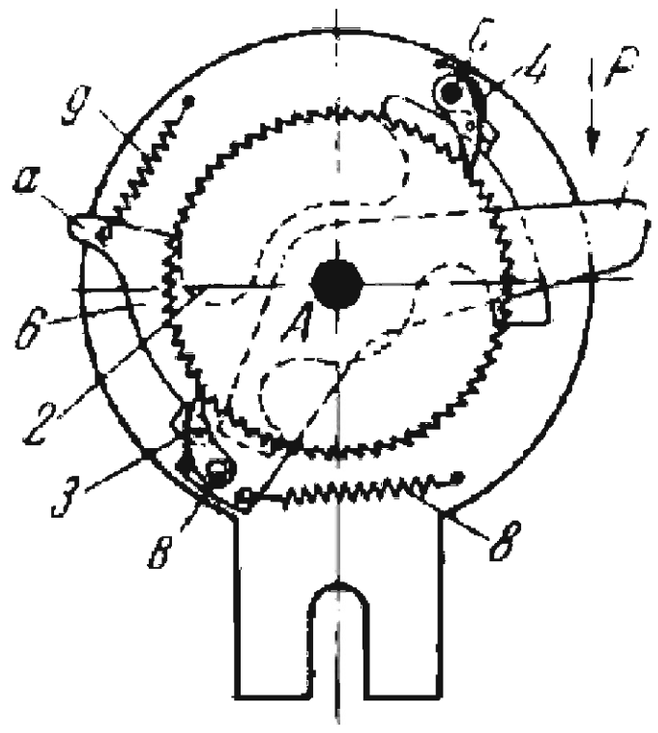


Latch *1* is pivoted to cross-head *2* which is reciprocated vertically by arm *3*. In the upward stroke, lower end *d* of latch *1* engages a tooth on bar *4*, carrying it upward. Upon further upward movement of cross-head *2*, upper end *a* of latch *1* runs against lower projection *c*, turning the latch counterclockwise and disengaging end *d* from the tooth of bar *4* which drops down by the action of spring *5*. The lower end of the latch is held away from the bar only momentarily; as the upper end passes projection *c*, lower end *d* engages the next tooth on bar *4* which continues its upward motion until upper end *a* of latch *1* reaches the next projection *c* when bar *4* is dropped again. At the end of the upward stroke of cross-head *2*, bar *4* is held suspended by latch *1*, but is dropped to its lowest position when in the down stroke upper end *a* of latch *1* reaches upper projection *c*. The intermittent motion of bar *4* is used to agitate the workpieces in a hopper feeding device.

10. MECHANISMS OF MEASURING AND TESTING DEVICES (1845)

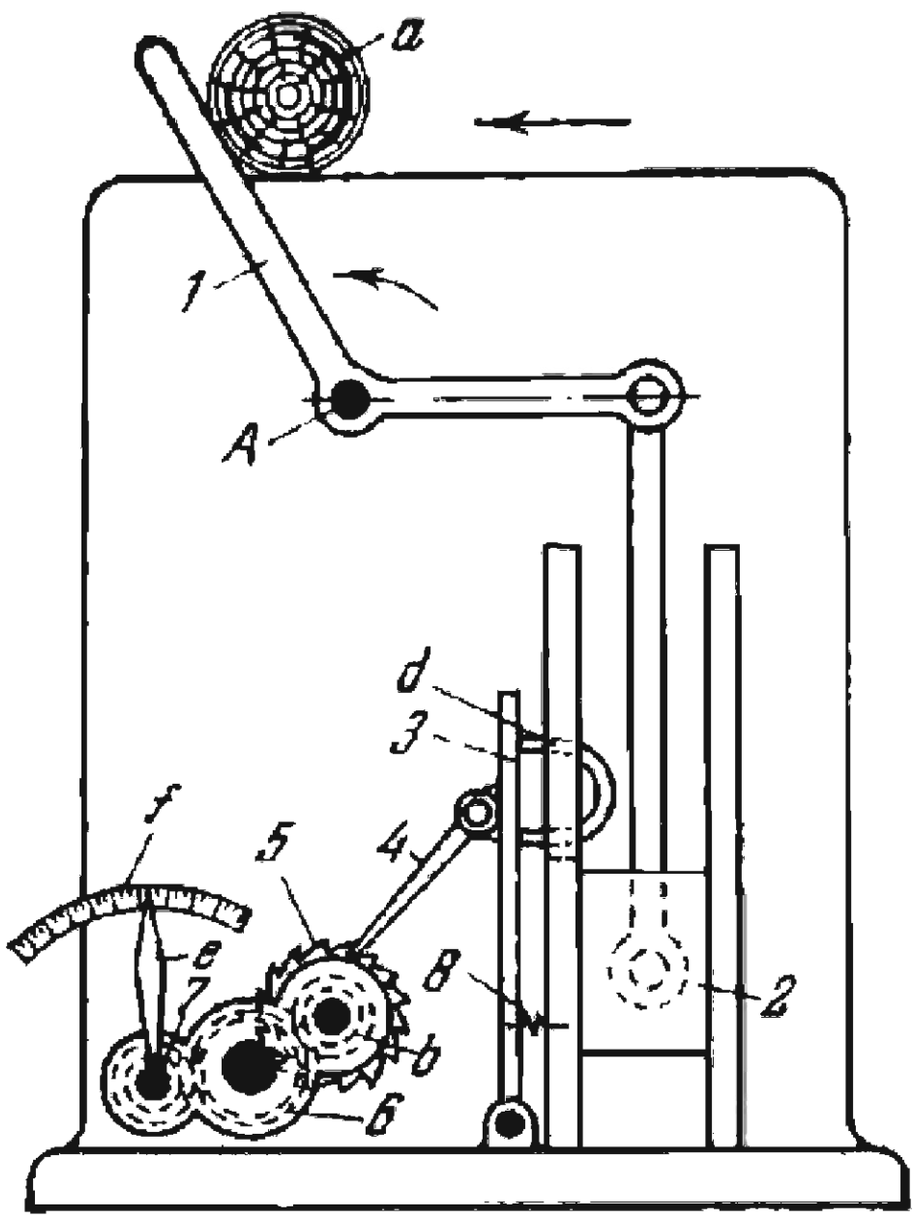
1845	LEVER-RATCHET COUNTER MECHANISM	LR M





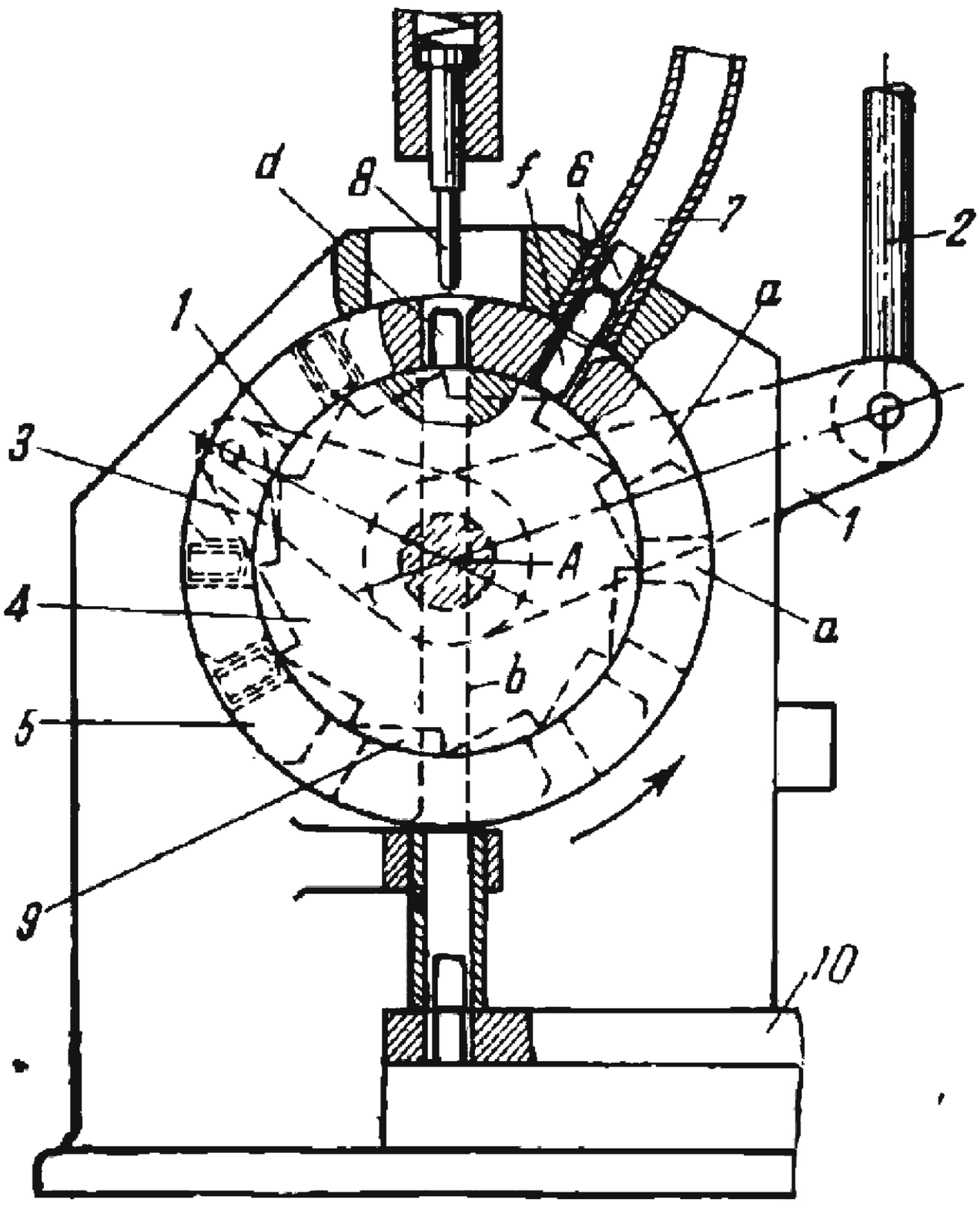
Each piece to be registered by the counter moves in the direction of arrow *P* and runs against lever *1*, turning it clockwise about fixed axis *A*. This turns ratchet wheel *2* and pawl *3* through one tooth about axis *A*. Pawl *4* turns about fixed axis *C* and prevents reverse rotation of wheel *2*. Disk *5* with a scale indicates the number of pieces that have passed the counter. Disk *5* is zeroed (returned to its initial position) by pressing projection *a* of cam *6* which forces pawls *3* and *4* away from ratchet wheel *2*. Then wheel *2* together with disk *5* is turned backwards by wound-up spiral spring *7* to their initial position. Springs *8* and *9* return lever *1* and cam *6* to their working position when projection *a* is released.

1846	LEVER-RATCHET LOG COUNTER MECHANISM	LR FD



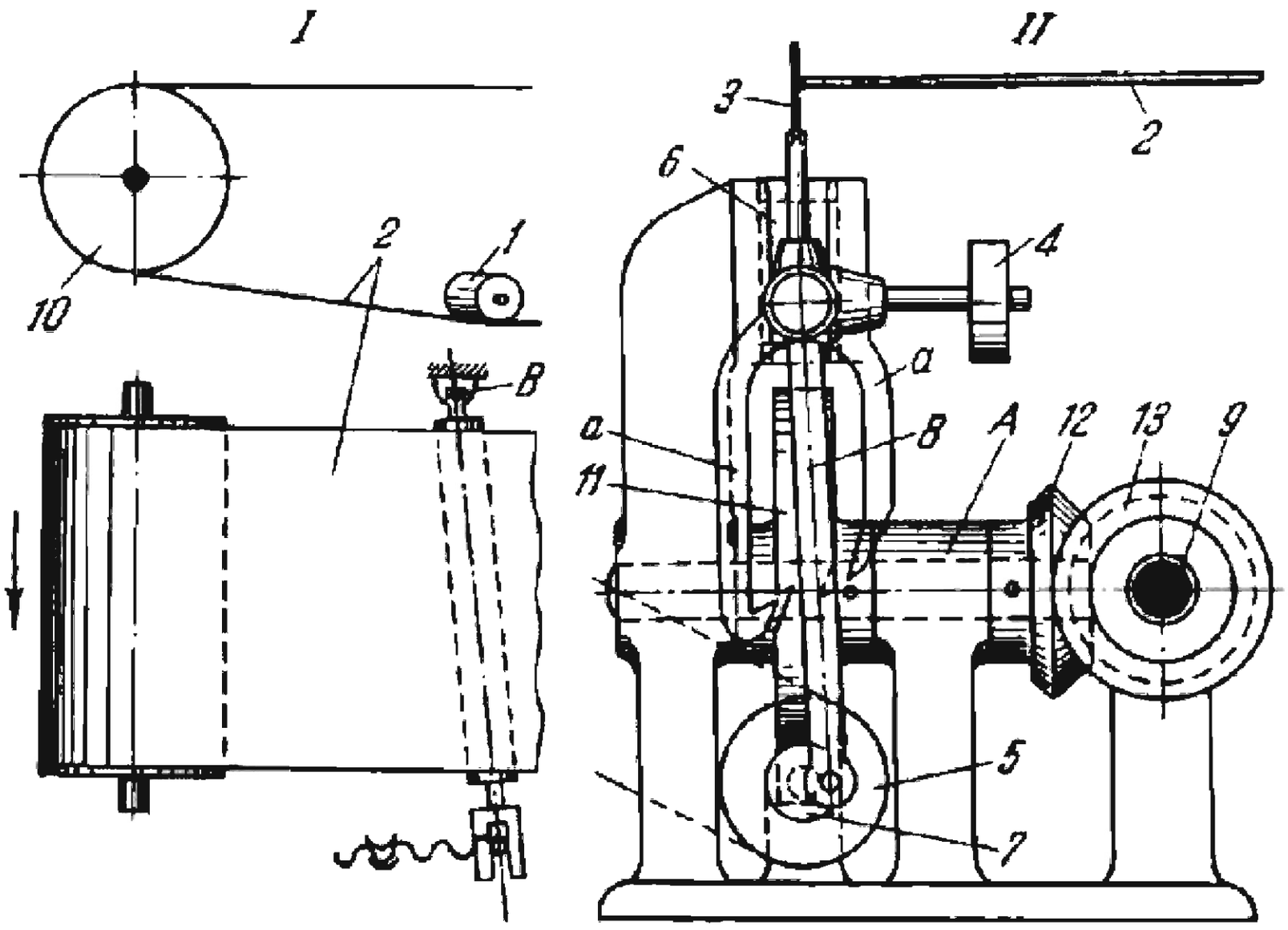
As log *a* rolls to the left it turns lever *1* counterclockwise about fixed axis *A*. This raises slider *2*, forcing yoke *d* of lever *3* to the left so that pawl *4* turns ratchet wheel *5* counterclockwise. Wheel *5* is rigidly attached to gear *b* which meshes with gear *6*. The rotation of gear *b* is indicated on scale *f* by meshing gears *6* and *7* and hand *e*. Spring *8* returns lever *3* to its initial position.

1847	LEVER-RATCHET SHELL-FEEDING MECHANISM	LR FD

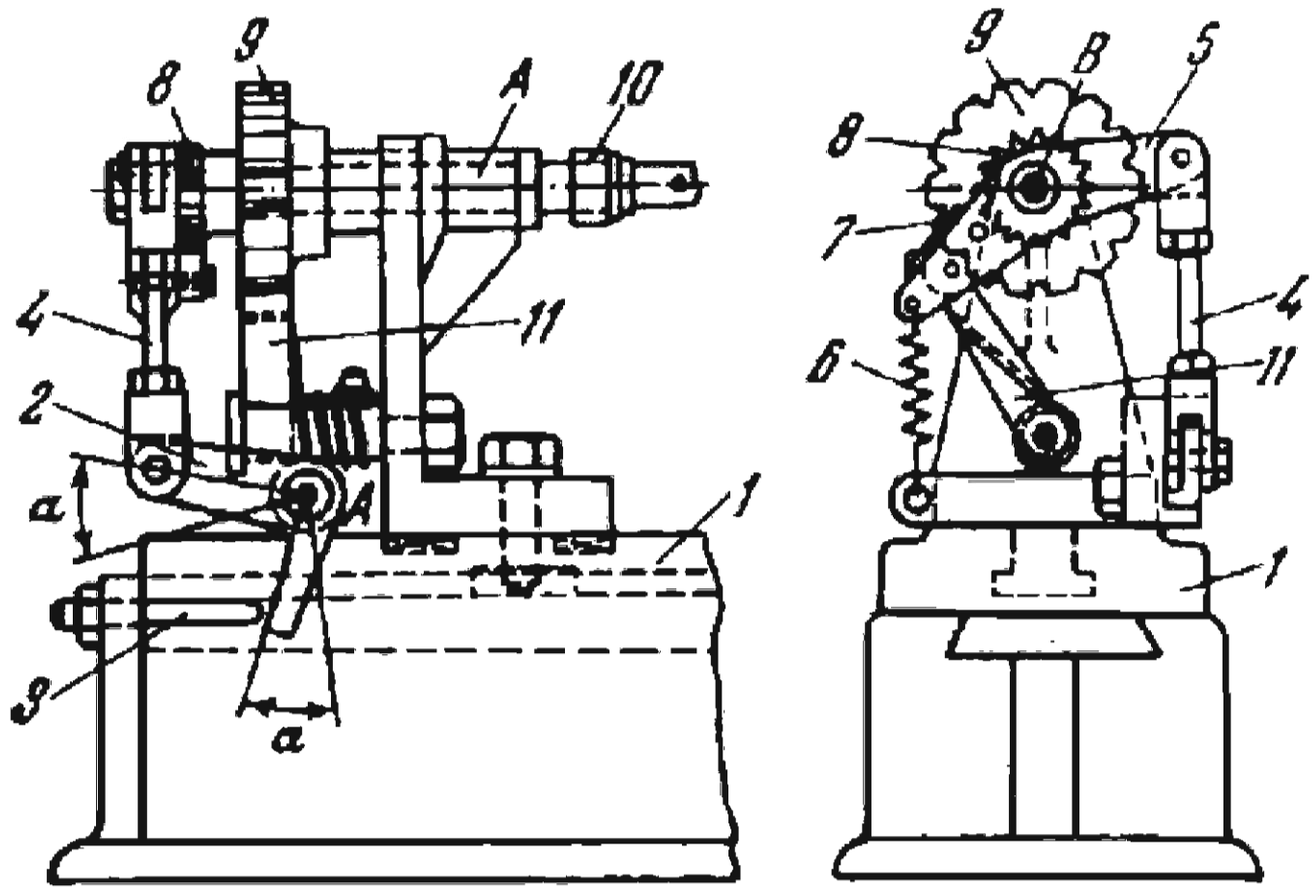


Bent lever *1* turns about fixed axis *A* and is oscillated by link *2* which is secured to the press ram. By means of pawl *3*, lever *1* turns ratchet wheel *4* together with annular ring *5* intermittently counterclockwise about axis *A*. For each cycle of the press ram, ring *5* is turned one division. Shells *6* are fed from a hopper through tube *7* and drop, one by one, into openings *a* of ring *5*. Shells may leave the hopper and drop through tube *7* with their closed ends either up or down, but they must all be delivered to press dial *10* with their closed ends up. Shells *6* entering ring *5* in the position shown at *d* (closed end up) are pushed by plunger *8*, overcoming the resistance of a spring (not shown), down through hole *b* in stationary disk *9* and drop in this position into the holes of press dial *10*. Shells entering ring *5* in the position shown at *f* (closed ends down) are carried past the position at the top of ring *5* (past hole *b*) because plunger *8* will simply enter the shell without making contact. These shells cannot drop by gravity into hole *b* because they are held up by the spring (not shown). Such shells will be carried around and drop out in the proper position into a hole of press dial *10*.

1848	LEVER-RATCHET BELT ADJUSTMENT MECHANISM	LR FD

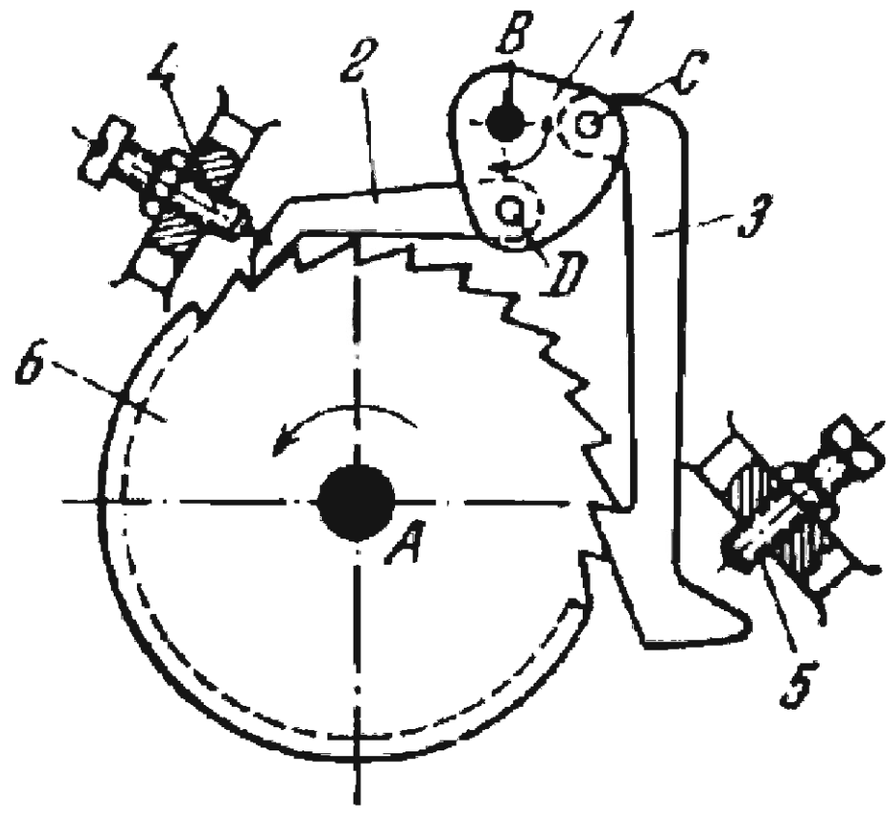


When **belt *2* starts** to slip off its pulleys, for example, in the direction shown by the arrow, guide roller *1* turns about fixed axis *B* (see Fig. I). The friction force between belt *2* and roller *1* returns the belt to its central position. The roller is turned by the mechanism shown in Fig. II. Weight *4* holds link *3* in constant contact with the edge of belt *2*. Pulley *5*, powered from an independent drive, reciprocates slider *6* through crank *7* and connecting rod *8*. Slider *6* is connected by a turning pair to link *3*. When belt *2* is in its proper position, link *3* is in the position shown in Fig. II and pawls *a*, rigidly attached to link *3*, idle. When belt *2* begins to slip off in either direction, link *3* is deviated with the pawls. At this one of the pawls transmits intermittent rotation in the required direction to ratchet wheel *11* which is keyed on shaft *A* together with bevel gear *12*. This gear meshes with bevel gear *13* which turns screw *9*. By means of a nut (shown schematically with the screw in Fig. I) screw *9* turns roller *1* in the required direction about axis *B*.



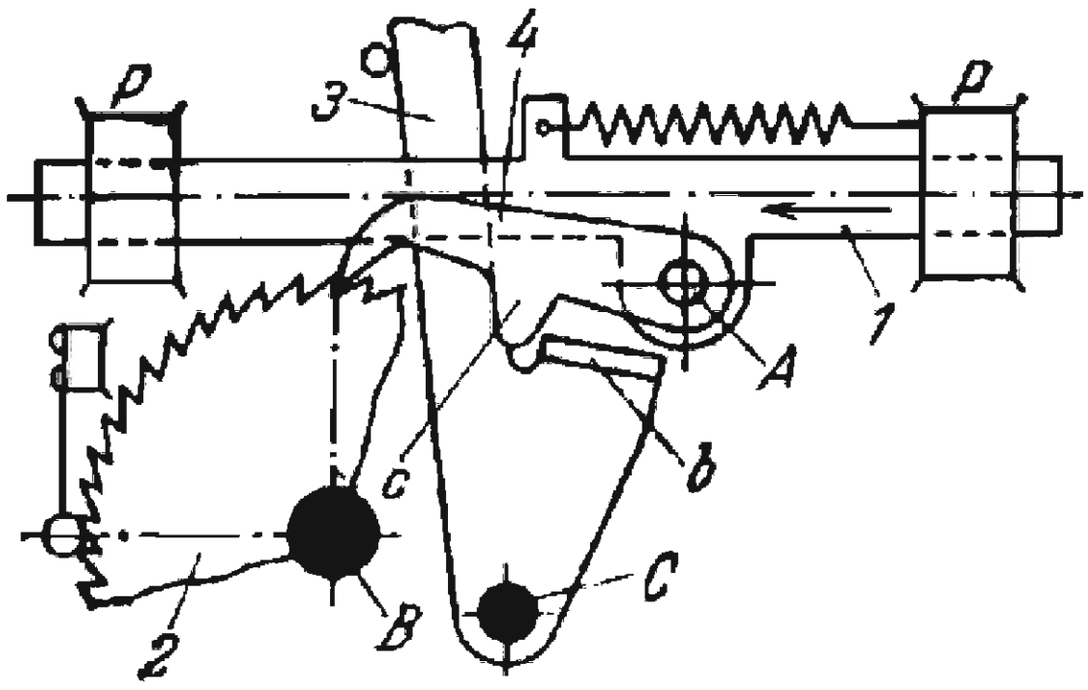
When table *1* is traversed to the left, bellcrank *2*, running against stop *3*, turns through the required angle α about axis *A*. Then table *1* stops. Motion is transmitted to tie-rod *4* which, moving downward, turns two-arm lever *5* about fixed axis *B*, overcoming the resistance of spring *6*. At this, pawl *7*, pivoted on lever *5*, turns ratchet wheel *8* through one tooth. Wheel *8* turns together with shaft *A* on which indexing plate *9* is keyed and which carries workpiece *10* to be laid out. When workpiece *10* has been indexed through the required angle, table *1* is traversed in the reverse direction. Locking member *11* holds workpiece *10* in the indexed position.

1850	LEVER-RATCHET MECHANISM OF AN ELECTRIC CLOCK	LR FD



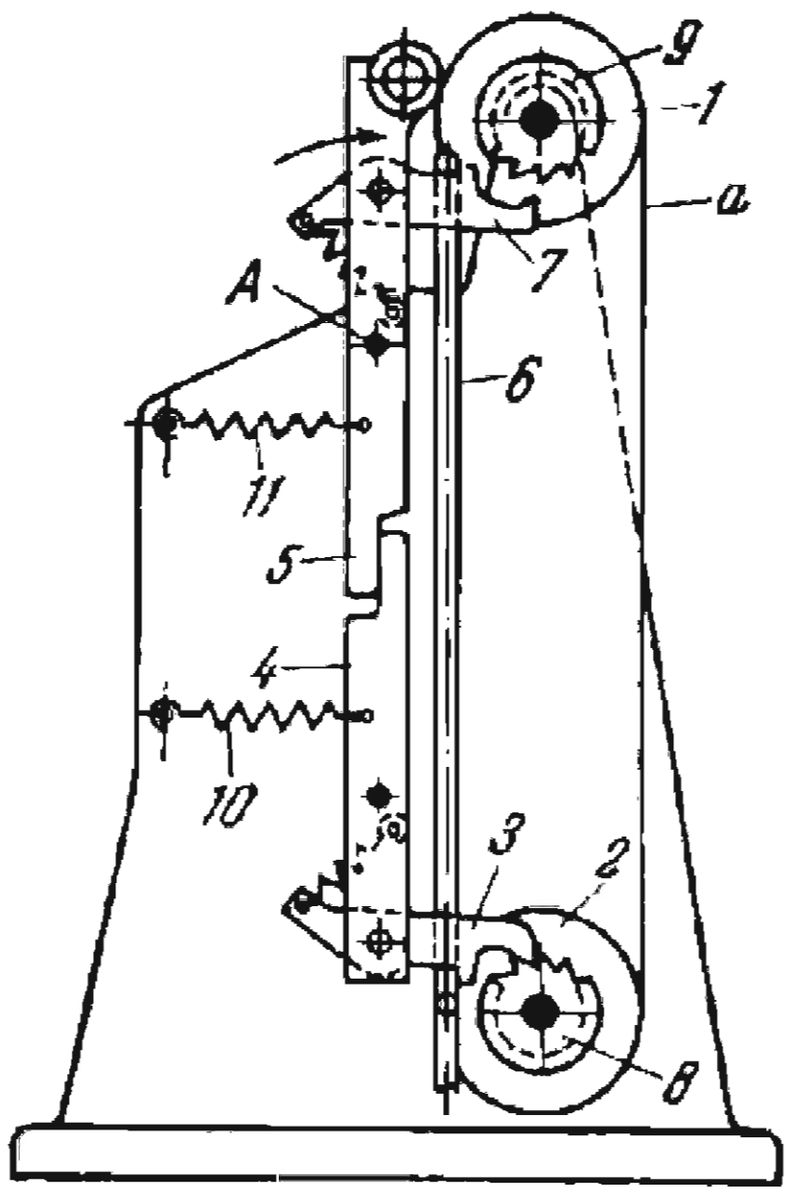
Link *1* turns about fixed axis *B* and is connected by turning pairs *D* and *C* to pawls *2* and *3* which engage ratchet wheel *6*. Wheel *6* rotates about fixed axis *A*. When link *1* oscillates, pawls *2* and *3* alternately turn ratchet wheel *6* one tooth. Adjustable screw stops *4* and *5* limit the movement of the pawls to keep them from skipping teeth of the ratchet wheel.

1851	LEVER-RATCHET LINE-SPACING MECHANISM OF A TYPEWRITER	LR FD



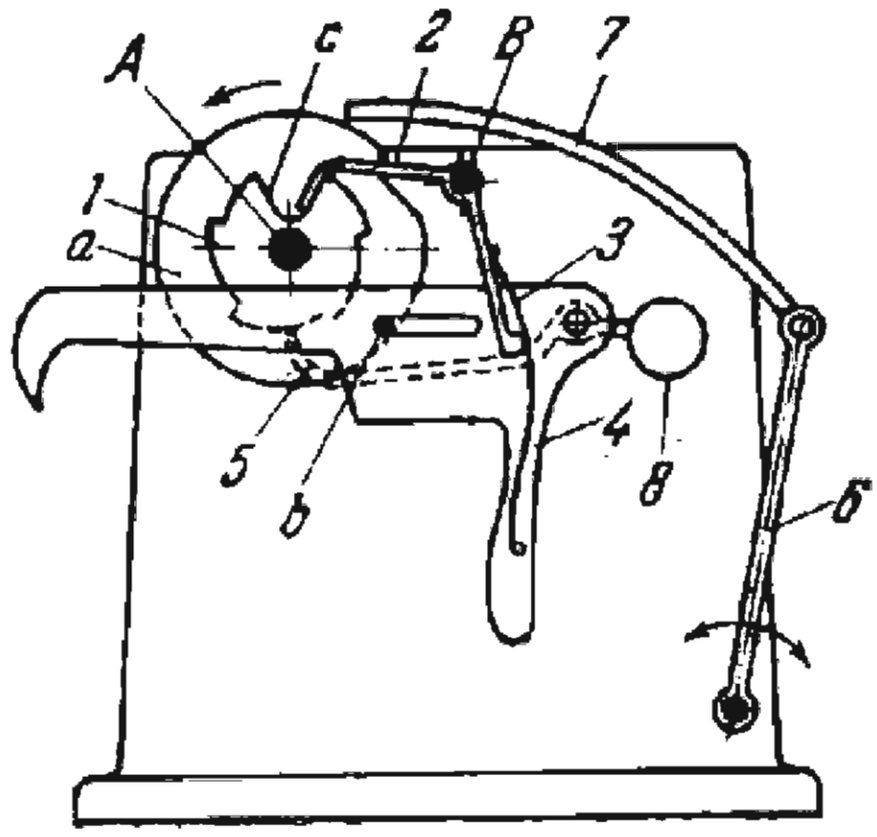
Rod *1* slides in fixed guides *p-p* and is connected by turning pair *A* to pawl *4*. Ratchet wheel *2* rotates about fixed axis *B*. When rod *1* moves to the left, pawl *4* turns ratchet wheel *2* together with the platen (roller), attached to the wheel, and the paper (not shown). The spacing between the typewritten lines is adjusted by turning lever *3* along whose lug *b* projection *c* of pawl *4* slides before the pawl engages and turns ratchet wheel *2*.

1852	LEVER-RATCHET MECHANISM FOR REVERSING THE TAPE IN A MASTER CLOCK	LR FD



When lever *5* is turned clockwise about fixed axis *A*, lever *4* turns counterclockwise and moves pawl *3* which turns ratchet wheel *8*. At this, tape *a* is unwound from reel *1* and wound on reel *2*. When tie-rod *6* is shifted upward, pawl *3* is disengaged from wheel *8* and pawl *7* engages ratchet wheel *9*. Now when lever *5* is turned clockwise, pawl *7* turns ratchet wheel *9* and the motion of tape *a* is reversed. Springs *10* and *11* hold the links in contact with one another.

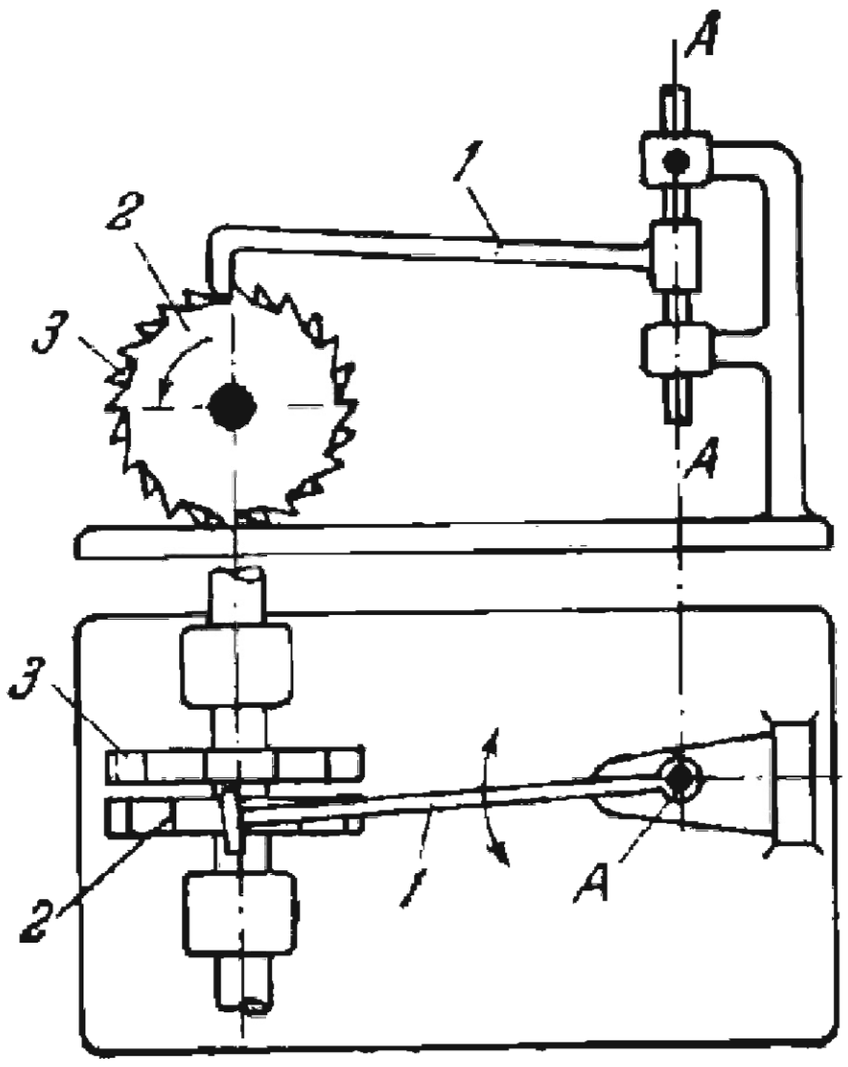
1853	LEVER-RATCHET MECHANISM OF A THREAD-CUTTING KNIFE	LR FD



Five-tooth ratchet wheel *1* rotates freely on fixed axis *A*. Disk *a* with one tooth space is mounted on a common hub with ratchet wheel *1*. Wheel *1* has recess *c* on its surface. Locking pawl *2* turns about fixed axis *B*. One end of flat spring *3* is attached to pawl *2* and the other end to knife *4*. Knife *4* has a longitudinal slot which slides along pin *b* fixed in the frame. Attached to the knife is feeding pawl *5* with weight *8*, holding pawl *5* from underneath against ratchet wheel *1*. In the idle position, the tooth of pawl *2* is in the recess of wheel *1* and knife *4* is withdrawn. When link *6* is turned clockwise, the tooth of pawl *7* enters the tooth space of disk *a*. When link *6* turns back again, pawl *7* turns disk *a* together with ratchet wheel *1*. At this, pawl *2* is forced out of the recess in wheel *1*, turns clockwise about axis *B*, and its other end is retracted from spring *3*. This allows knife *4* to advance and hook the thread.

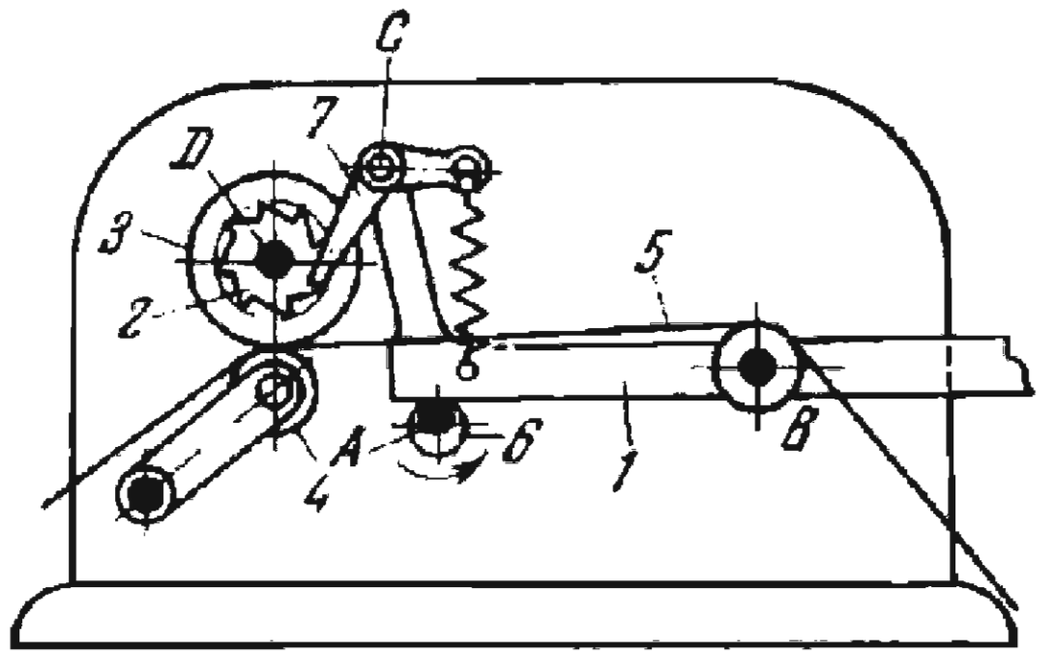
In its rapid retraction knife *4* cuts the thread.

1854	LEVER-RATCHET MECHANISM OF A TYPE-PRINTING TELEGRAPH	LR FD



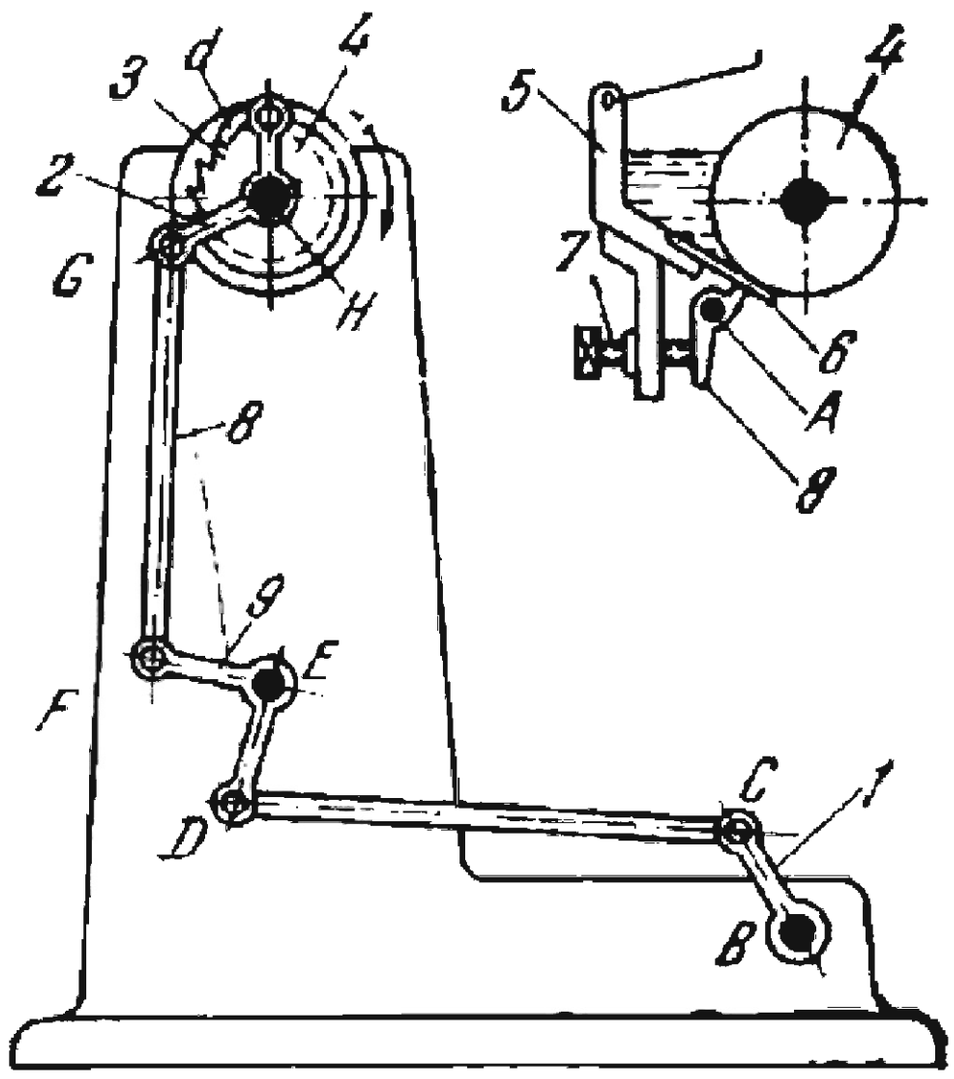
Pawl *1* turns about and slides along fixed axis *A*. When pawl *1* oscillates about axis *A*, it alternately stops and releases ratchet wheels *2* and *3* which are subject to constant torques.

1855	LEVER-RATCHET MECHANISM OF A TAPE-FEED DEVICE	LR FD



Eccentric *6* and lever *1* turn about fixed axes *A* and *B*. Lever *1* is connected by turning pair *C* to pawl *7* which engages ratchet wheel *2* rotating about fixed axis *D*. Roll *3* is rigidly attached to wheel *2*. When lever *1* is raised by eccentric *6*, pawl *7* slides upward over one tooth, and when lever *1* moves downward, pawl *7* turns ratchet wheel *2* together with roll *3*. This feeds tape *5*, squeezed between rolls *3* and *4*, to the left.

1856	LEVER-RATCHET MECHANISM FOR TURNING A DUCT ROLLER	LR FD



Lever *8* is connected by turning pairs *F* and *G* to bellcrank *9* of four-bar linkage *BCDE* and to lever *2* which turns about fixed axis *H*. Ratchet wheel *3* rotates about axis *H*. When crank *1* on the mainshaft rotates about fixed axis *B*, lever *2* is oscillated with pawl *d* pivoted on the lever. When lever *2* turns counterclockwise, pawl *d* turns ratchet wheel *3* through a certain angle, thereby turning duct roller *4* whose surface is inked. Ink feed to the type is regulated by varying the angle of rotation of the duct roller. Ink for printing is put into box *5* having three side walls, the fourth being duct roller *4*. Inking plate *6* is close to the roller underneath, forming a narrow slit. The width of the slit is adjusted by screws *7*.

SECTION NINE

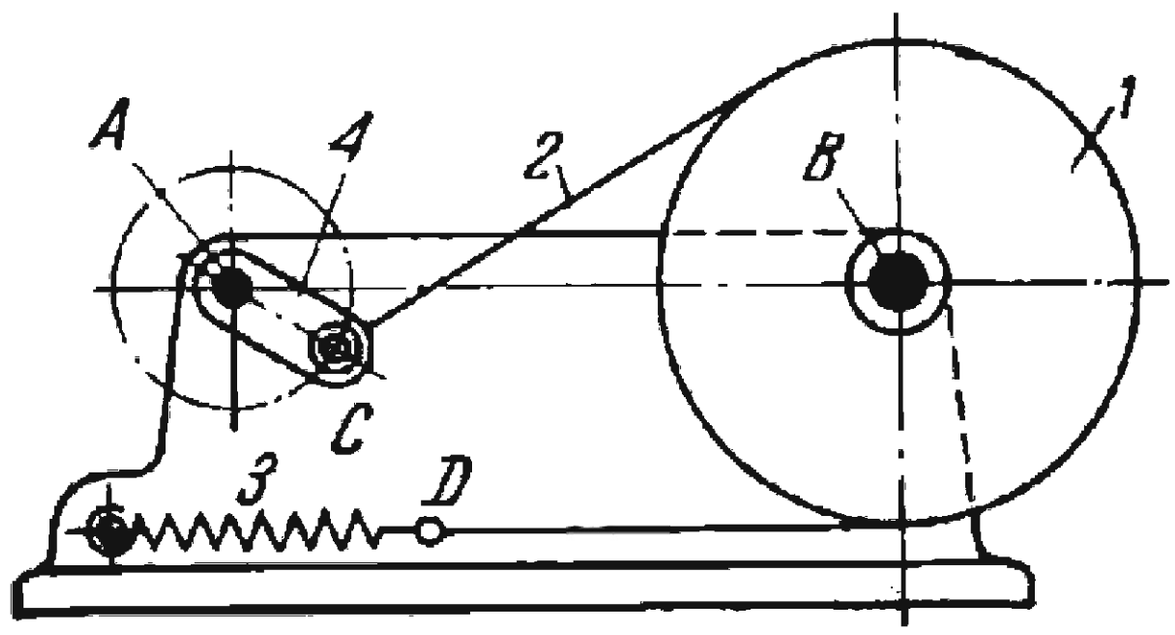
Flexible-Link Lever Mechanisms

FL

1. General-Purpose Four-Link Mechanisms 4L (1857 through 1860)
2. General-Purpose Five-Link Mechanisms 5L (1861 through 1865)
3. General-Purpose Six-Link Mechanisms 6L (1866 through 1890)
4. General-Purpose Multiple-Link Mechanisms ML (1891 through 1920)
5. Dwell Mechanisms D (1921 through 1938)
6. Crawler Mechanisms Cr (1939 through 1970)
7. Mechanisms of Measuring and Testing Devices M (1971 and 1972)
8. Sorting and Feeding Mechanisms SF (1973 and 1974)
9. Brake Mechanisms Br (1975 through 1985)
10. Tilting Crawler Mechanisms TC (1986 through 2016)
11. Balance Mechanisms B (2017 and 2018)
12. Mechanisms of Materials Handling Equipment MH (2019 through 2024)
13. Mechanisms for Generating Curves Ge (2025, 2026 and 2027)
14. Satellite Mechanisms Sa (2028 through 2104)
15. Mechanisms of Other Functional Devices FD (2105 through 2108)

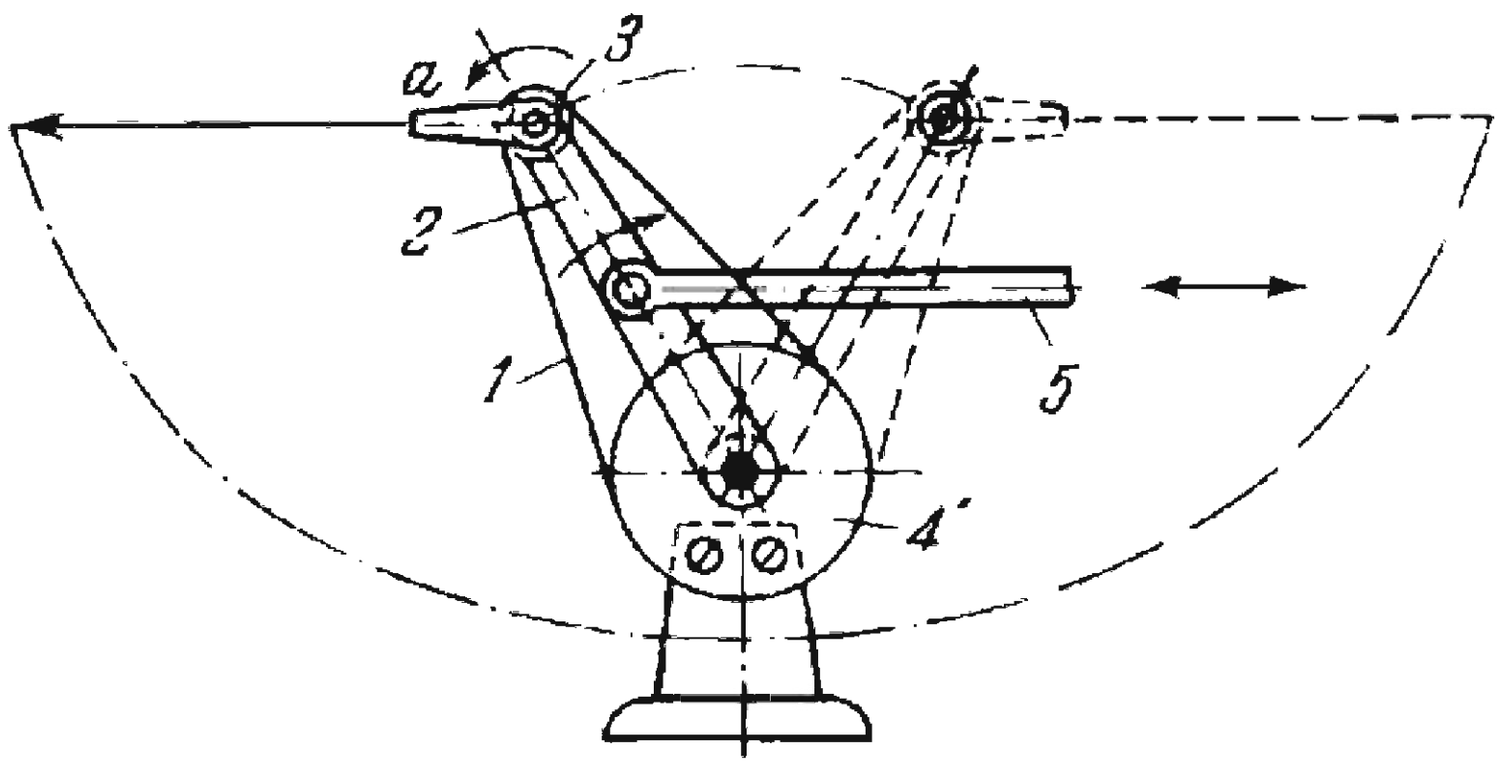
1. GENERAL-PURPOSE FOUR-LINK MECHANISMS
(1857 through 1860)

1857	FLEXIBLE-LINK LEVER MECHANISM	FL 4L



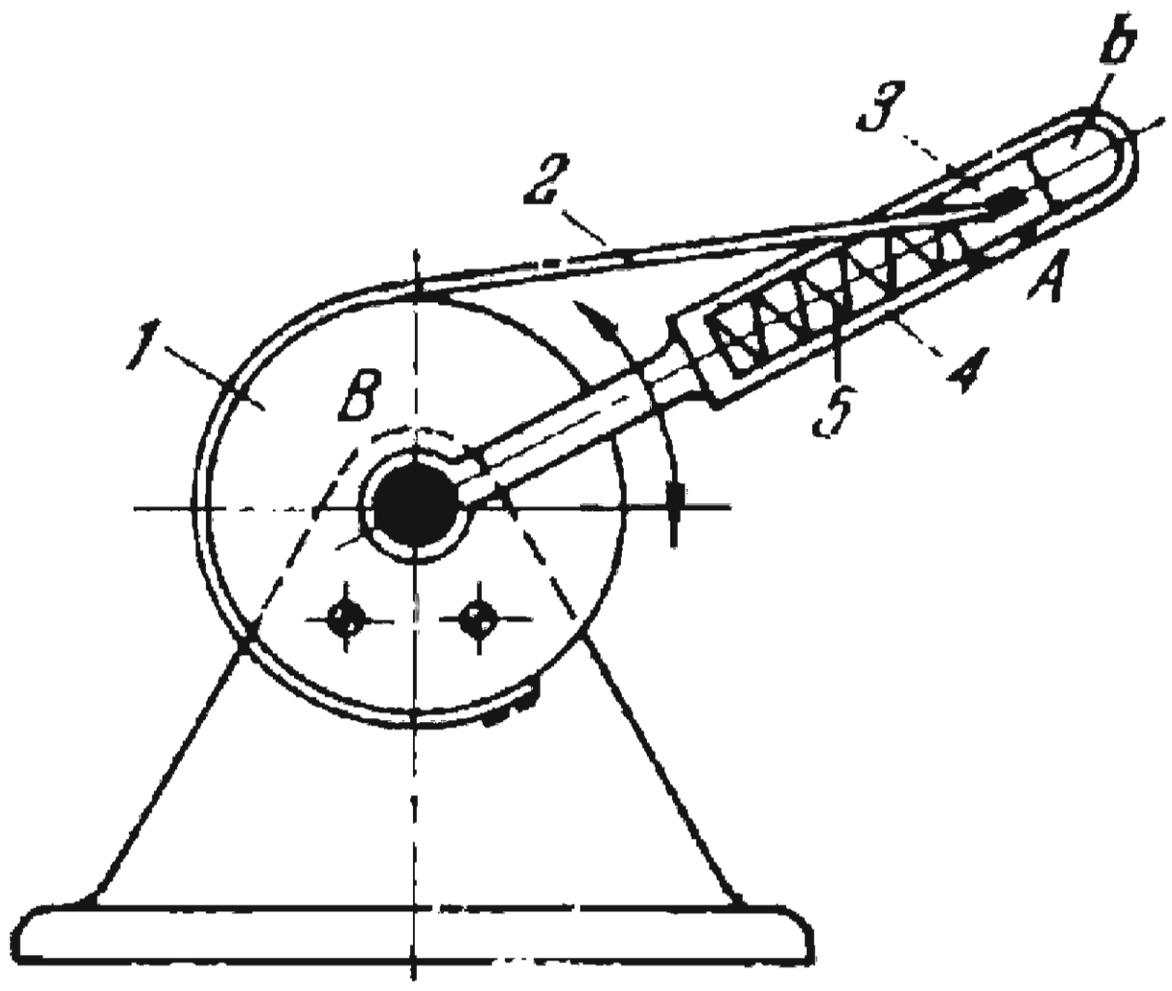
Flexible link *2*, running over pulley *1*, is connected with one end to crank *4* at point *C* and at the other to spring *3* at point *D*. When crank *4* rotates about fixed axis *A*, pulley *1* and shaft *B* are turned alternately in both directions.

1858	LINKWORK PLANETARY FLEXIBLE-LINK MECHANISM OF A WINDSHIELD WIPER	FL 4L



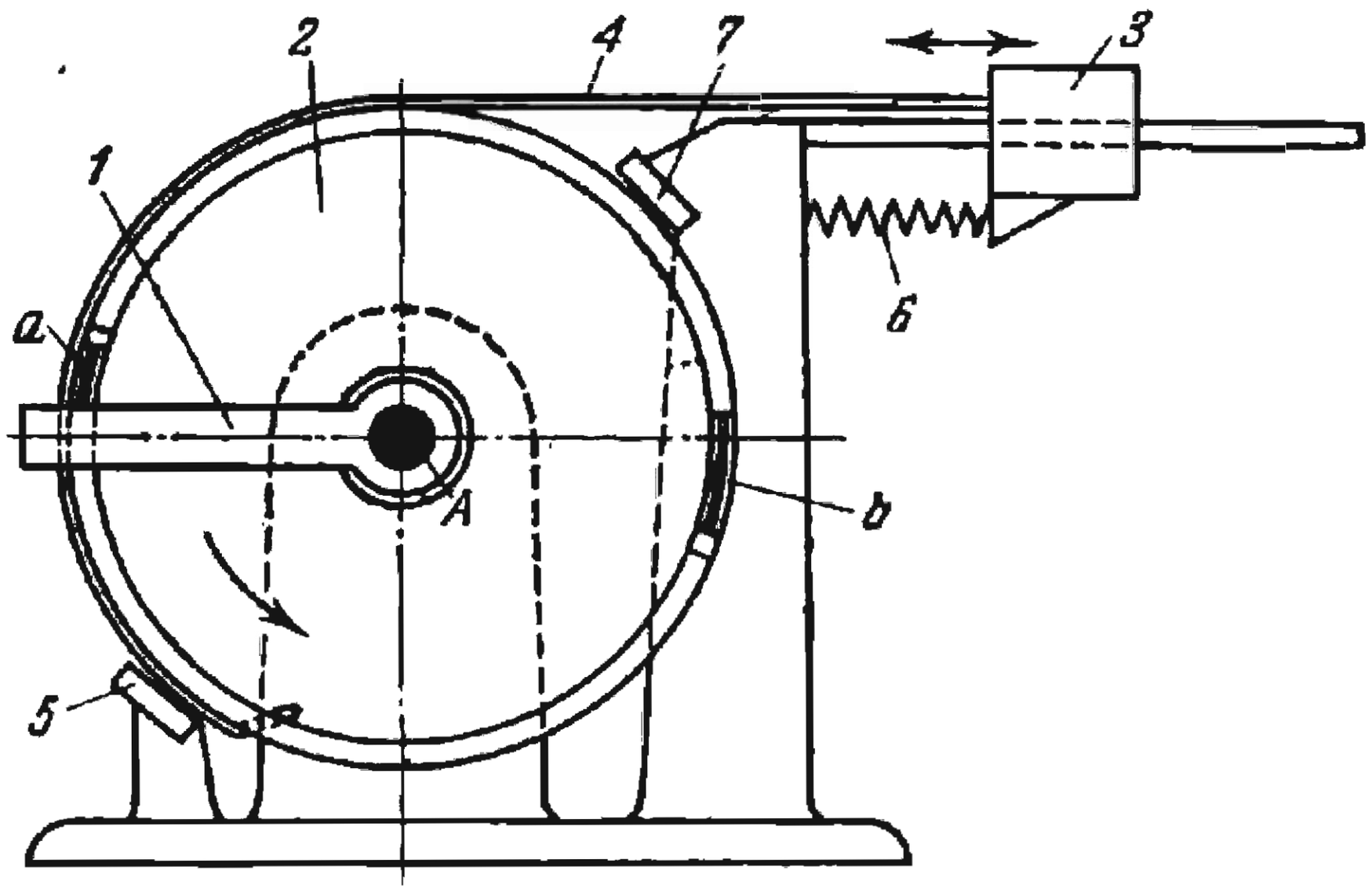
Flexible link *1* runs over fixed pulley *4* and pulley *3* which rotates freely on wiper arm *2*. Wiper arm *2* is oscillated by tie-rod *5* from a drive (not shown). Rigidly attached to pulley *3* is rod *a* on which the wiper blade is mounted. When arm *2* oscillates, pulley *3* together with rod *a* and the blade turns alternately in both directions.

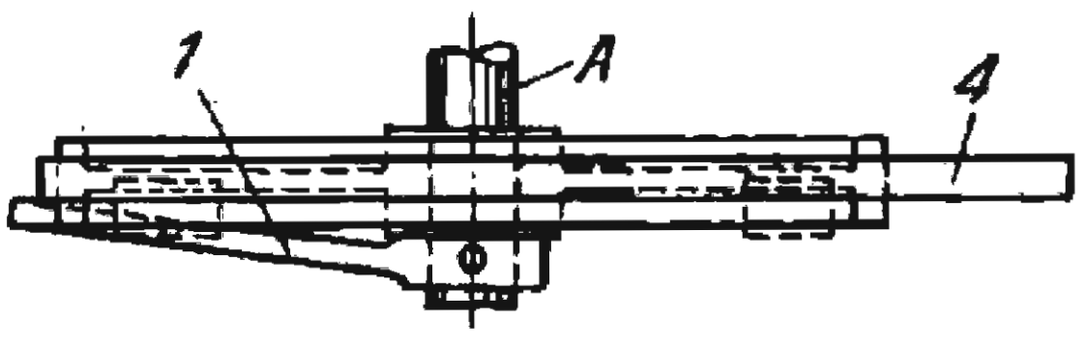
1859	LINK-GEAR FLEXIBLE-LINK MECHANISM	FL 4L



Pulley *1* is fixed to the base. Flexible link *2* runs over the pulley and is connected at point *A* to slider *3* which moves along guide *b* of slotted link *4*. When link *4* turns clockwise about fixed axis *B*, flexible link *2* winds on the pulley and moves slider *3* inward in guide *b*, compressing spring *5*. When slider *3* reaches its extreme inward position, slotted link *4* begins to turn in the opposite direction (counterclockwise).

1860	FLEXIBLE-LINK LEVER MECHANISM FOR CONVERTING ROTATION INTO RECIPROCATING MOTION	FL 4L

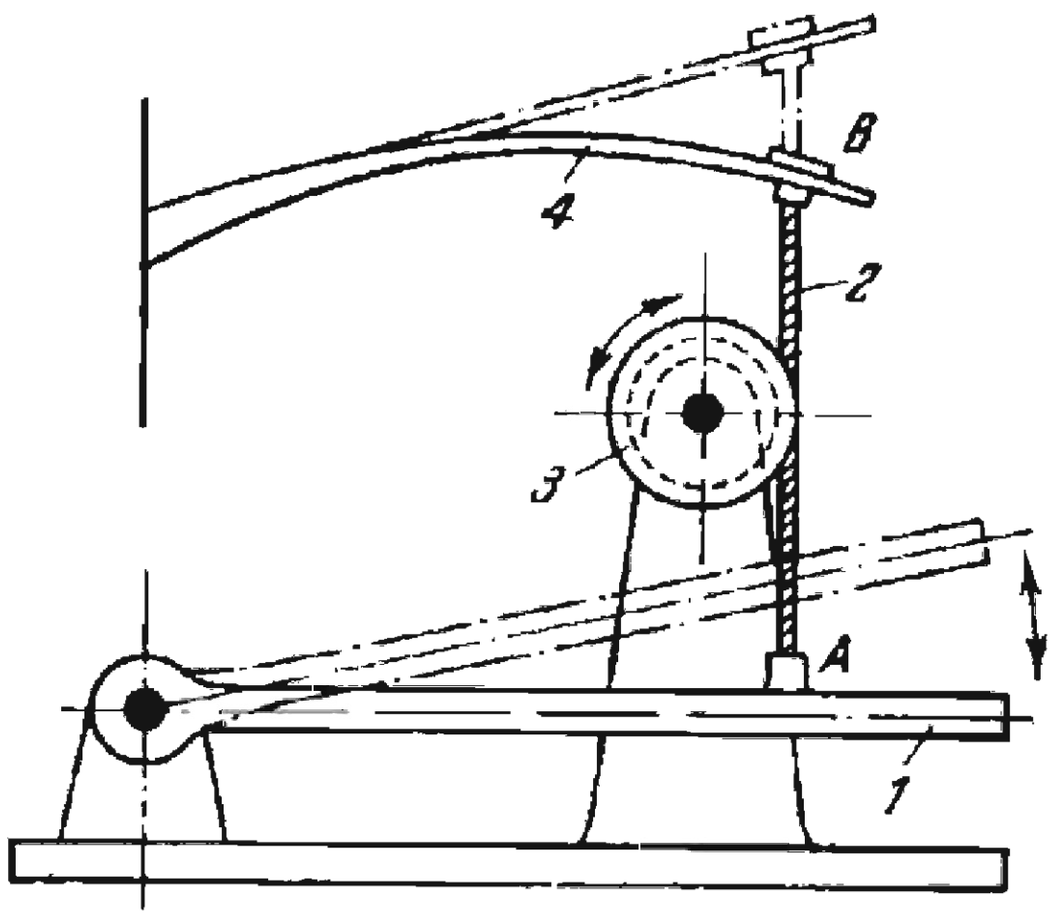




Lever *1* is rotated counterclockwise about fixed axis *A*. Disk *2*, mounted freely on shaft *A*, remains at rest until lever *1* reaches slot *a* in disk *2*. After this, disk *2* begins to rotate together with lever *1*, and slider *3*, connected by steel band *4* to disk *2*, moves to the left. When lever *1* reaches bevelled stop *5*, it is withdrawn from slot *a* and slider *3* is moved to the right by compressed spring *6*. This also reverses disk *2*. Lever *1*, continuing to rotate in the same direction, reaches slot *b* in disk *2* and slider *3* again moves to the left. Then bevelled stop *7* again disengages lever *1* from disk *2*, and slider *3* is moved again to the right by spring *6*. Thus, in each revolution of shaft *A*, slider *3* has two complete strokes (twice to the left and twice to the right).

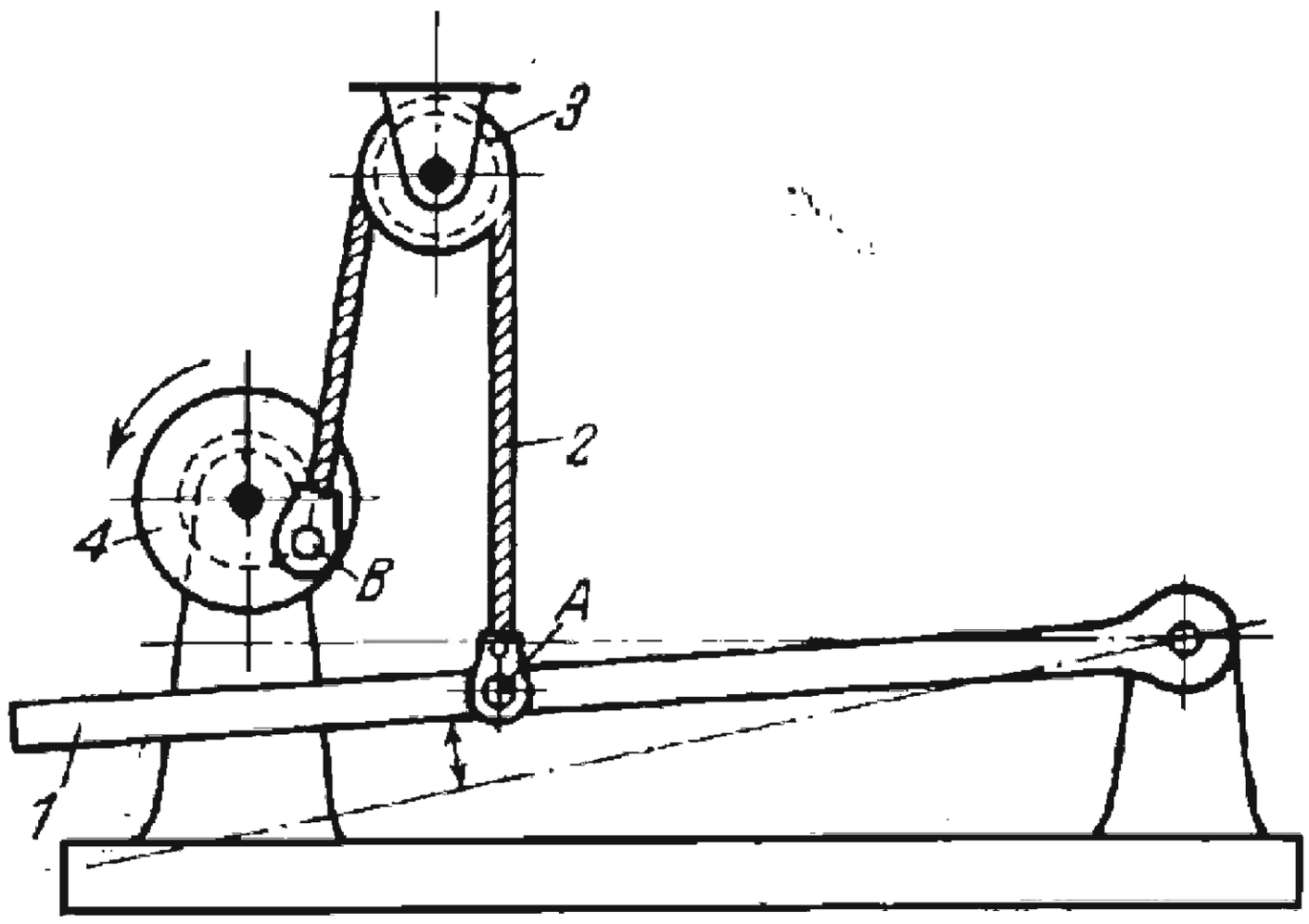
2. GENERAL-PURPOSE FIVE-LINK MECHANISMS (1861 through 1865)

1861	LEVER-TYPE TREADLE DRIVE WITH FLEXIBLE AND ELASTIC LINKS	FL 5L



Flexible link *2* is secured to treadle *1* at point *A*. Then link *2* is wound 360° around pulley *3* and is secured to elastic link *4* at point *B*. Pulley *3* rotates clockwise when treadle *1* is depressed, bending link *4* downward. When treadle *1* is released, link *4* straightens out and pulley *3* rotates counterclockwise.

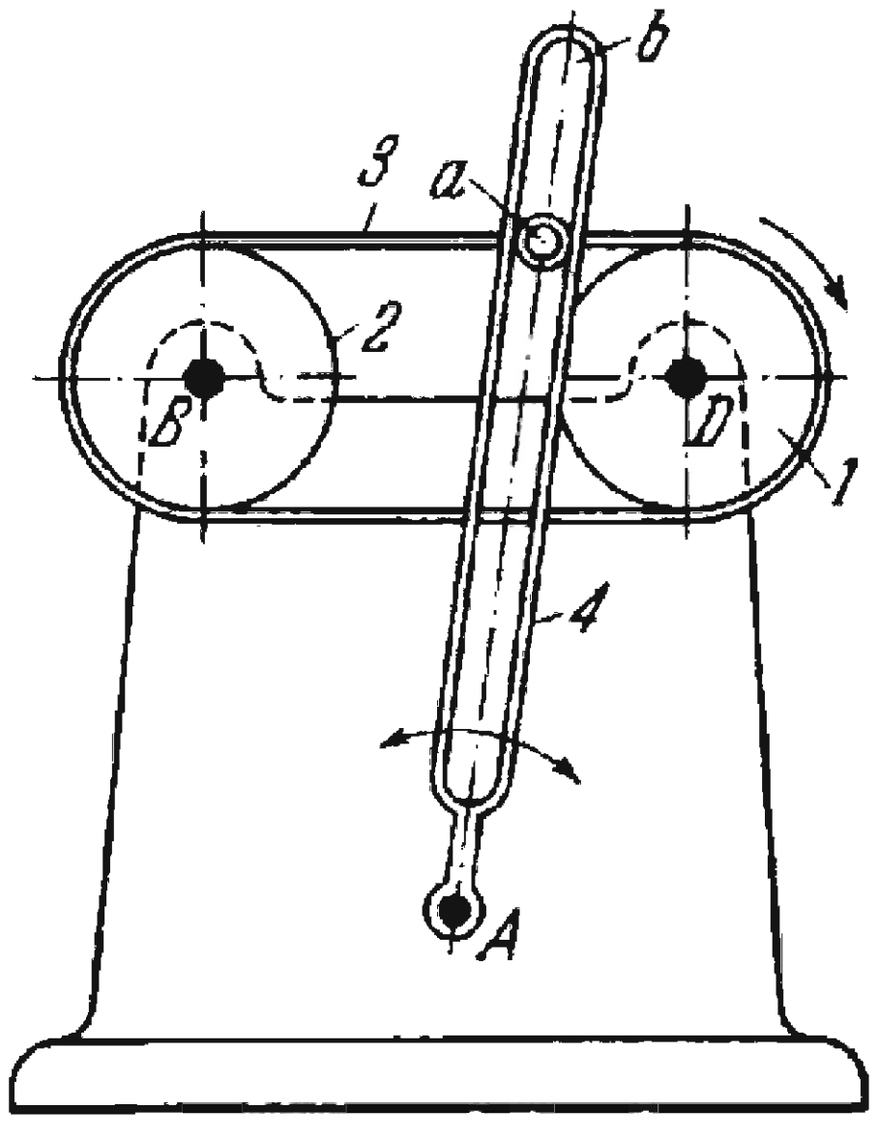
1862	LEVER-TYPE TREADLE DRIVE WITH A FLEXIBLE LINK	FL 5L



One end of flexible link *2* is secured at point *A* to treadle *1*. Then link *2* runs over pulley *3* and its other end is secured at point *B* to flywheel *4*. When treadle *1* is depressed, flywheel *4* is rotated. The dot-and-dash lines indicate the upper and lower positions of treadle *1*. The treadle is raised to its initial position by the inertia of flywheel *4*.

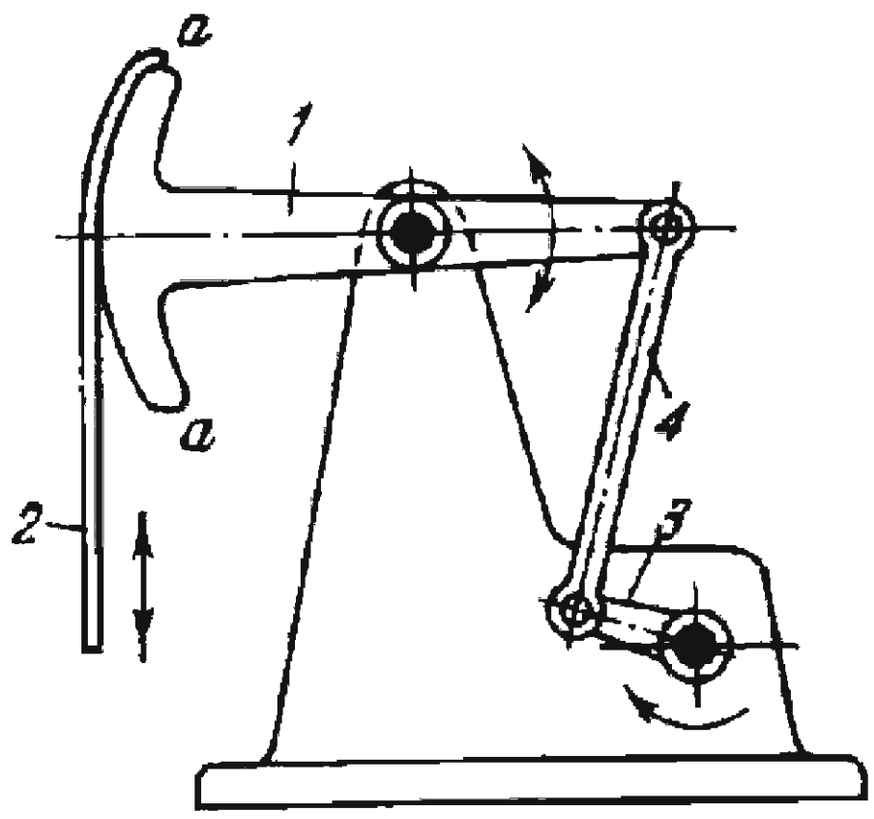
1863 LINK-GEAR MECHANISM WITH A FLEXIBLE LINK — FL 5L

Pulley *1* rotates about fixed axis *D* and, through flexible link *3*, rotates pulley *2* about fixed axis *B*. Pin *a* of flexible link *3* slides along slot *b* of slotted lever *4* which turns about fixed axis *A*. When pulley *1* rotates about axis *D*, link *4* oscillates about axis *A*. The law of motion of slotted link *4* per cycle can be changed by changing the positions of the axes of revolution of the pulleys.

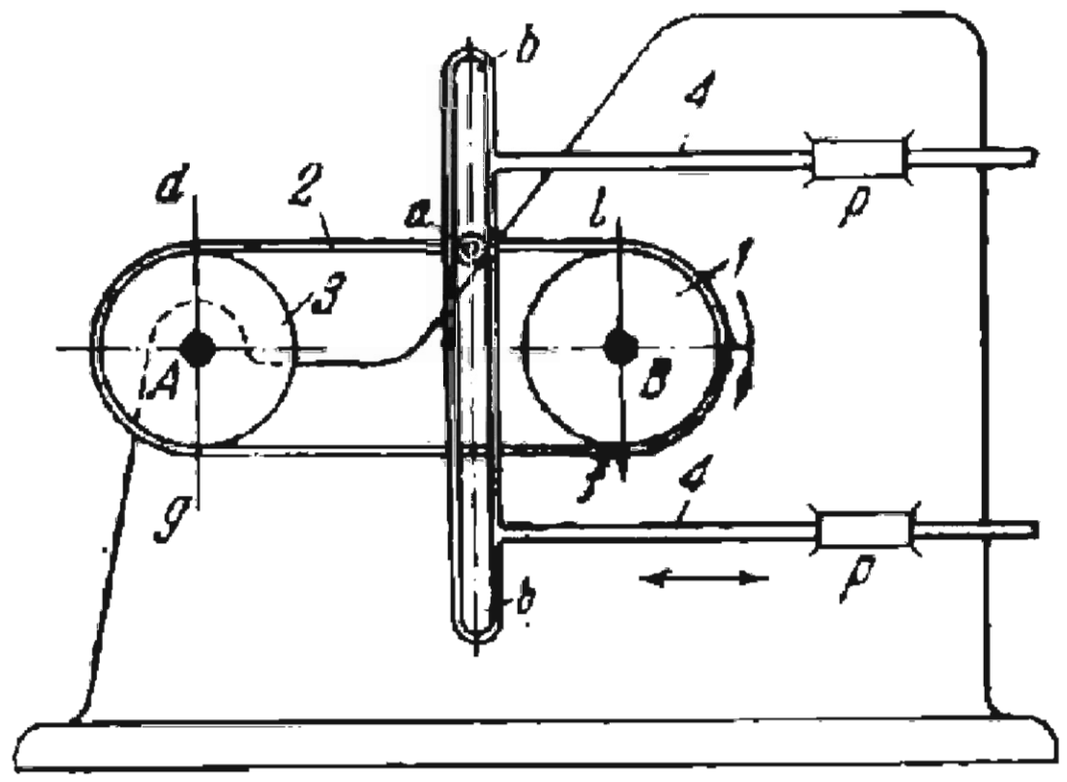


1864 LINKWORK MECHANISM WITH A FLEXIBLE LINK — FL 5L

Rocker arm *1* is oscillated by crank *3* whose rotation is transmitted through connecting rod *4*. As rocker arm *1* oscillates, flexible link *2* is alternately wound on and unwound from shaped sector *a-a* of the arm.



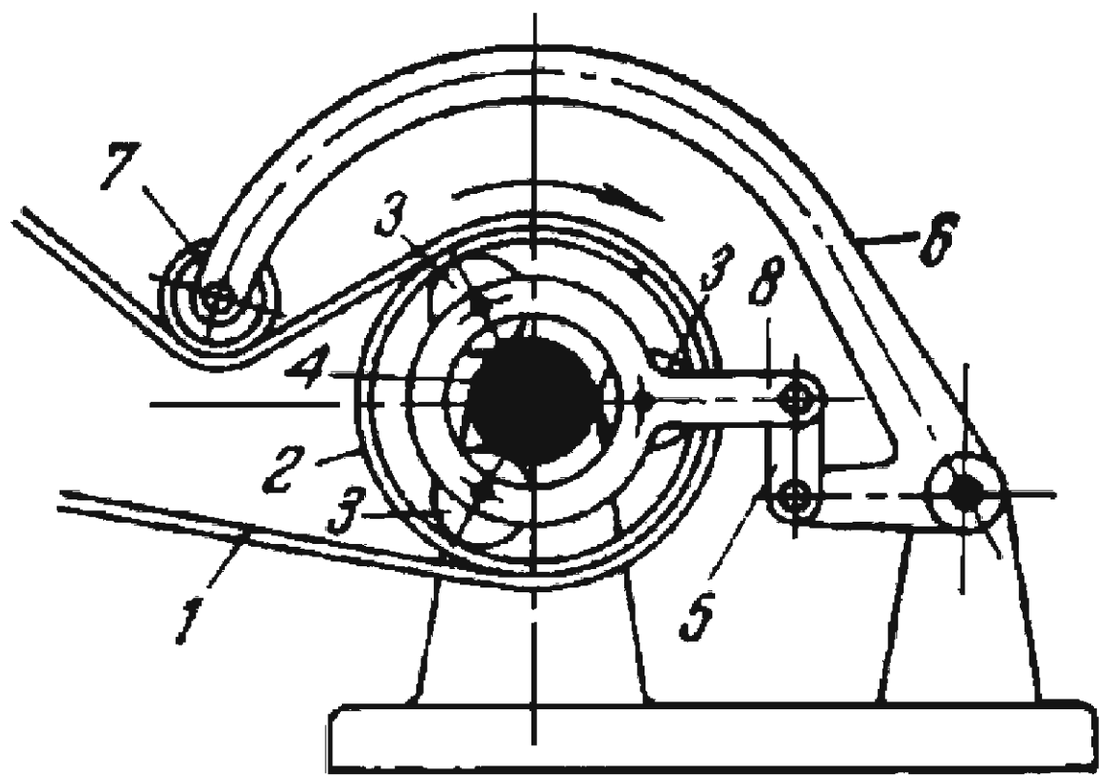
1865	SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK	FL 5L



Pulleys *1* and *3* are of equal diameter. Pulley *1* rotates about fixed axis *B* and, through flexible link *2*, rotates pulley *3* about fixed axis *A*. Pin *a* of flexible link *2* slides along slot *b*-*b* of slider *4* which moves in fixed guides *p*-*p*. When pulley *1* rotates about axis *B*, slider *4* reciprocates in guides *p*-*p*. If line *AB* is parallel to the axes of guides *p*-*p* and pulley *1* rotates at constant angular velocity ω_1, then, when pin *a* travels along portions *dl* and *fg* of its path, slider *4* travels with a constant velocity equal to $v = \omega_1 r_1$, where r_1 is the radius of pulley *1*.

3. GENERAL-PURPOSE SIX-LINK MECHANISMS
(1866 through 1890)

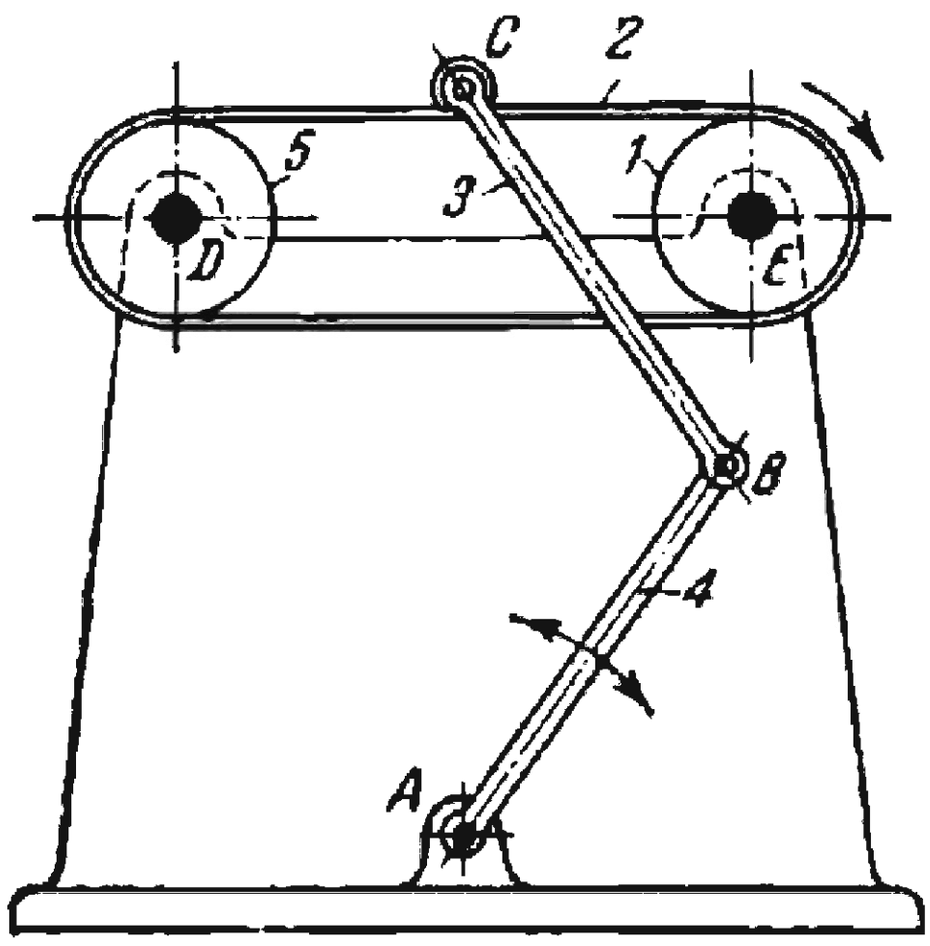
1866	LINKWORK PLANETARY MECHANISM OF AN IDLER PULLEY	FL 6L



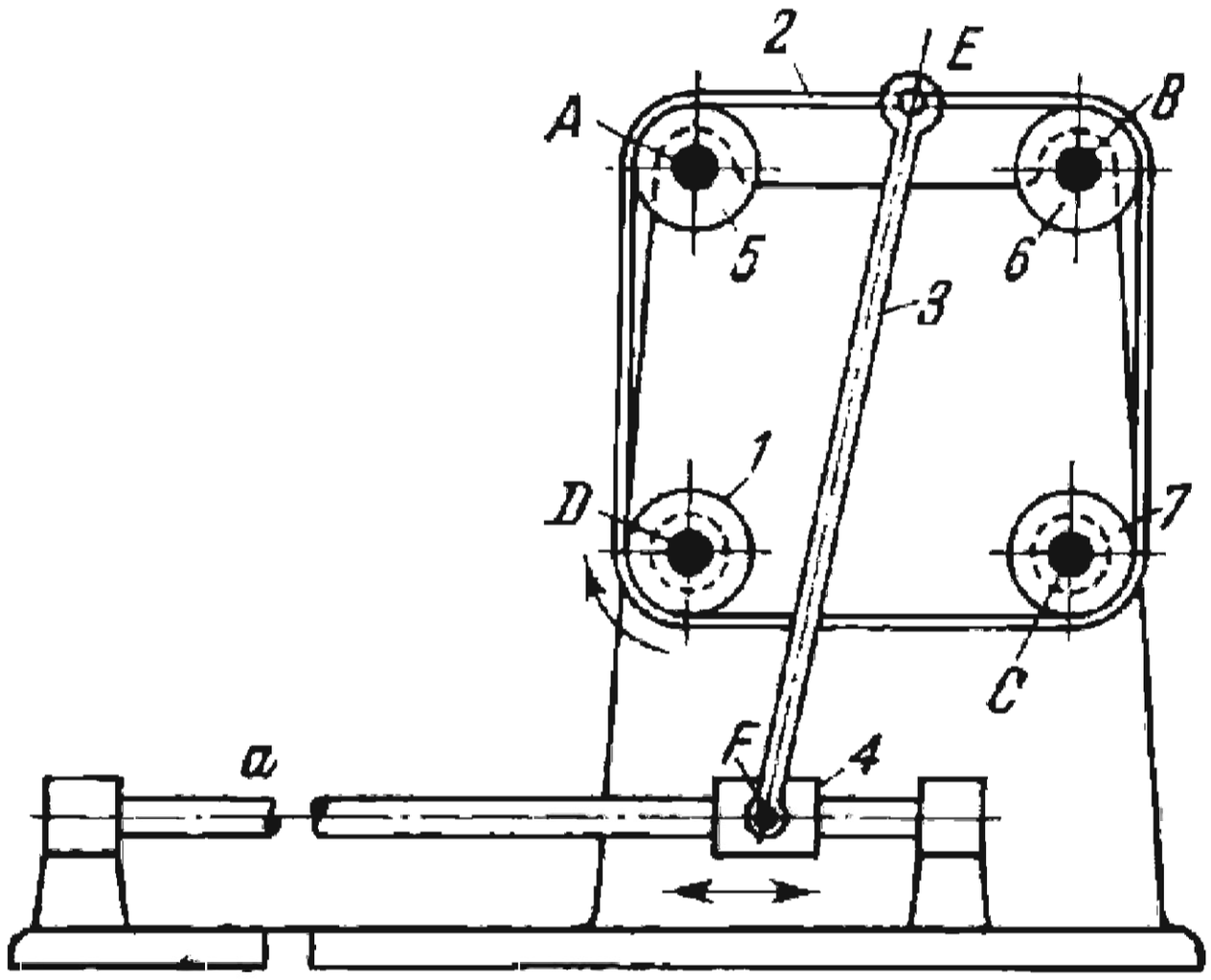
Flexible link *1* passes around pulley *2*. Rolling around the inside surface of pulley *2* are planet rollers *3*, connected by turning pairs to carrier *8*. Rollers *3* also roll around fixed wheel *4*. Acting through link *5* on lever *6* carrying idler roller *7*, carrier *8* tensions flexible link *1*.

1867	LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL 6L

Flexible link *2* runs over pulleys *1* and *5* which are of equal diameter. Flexible link *2* is connected by turning pair *C* to link *3* which, in turn, is connected by turning pair *B* to link *4*. When point *C* travels along the straight portions of its path, the motions of links *3* and *4* are equivalent to those of the connecting rod and crank of the offset slider-crank linkage *ABC*. When point *C* travels along the circular portions of its path, the motions of links *3* and *4* are equivalent to those of the connecting rod and rocker arm of a four-bar linkage in which the length of the crank equals the radius of the pulleys.

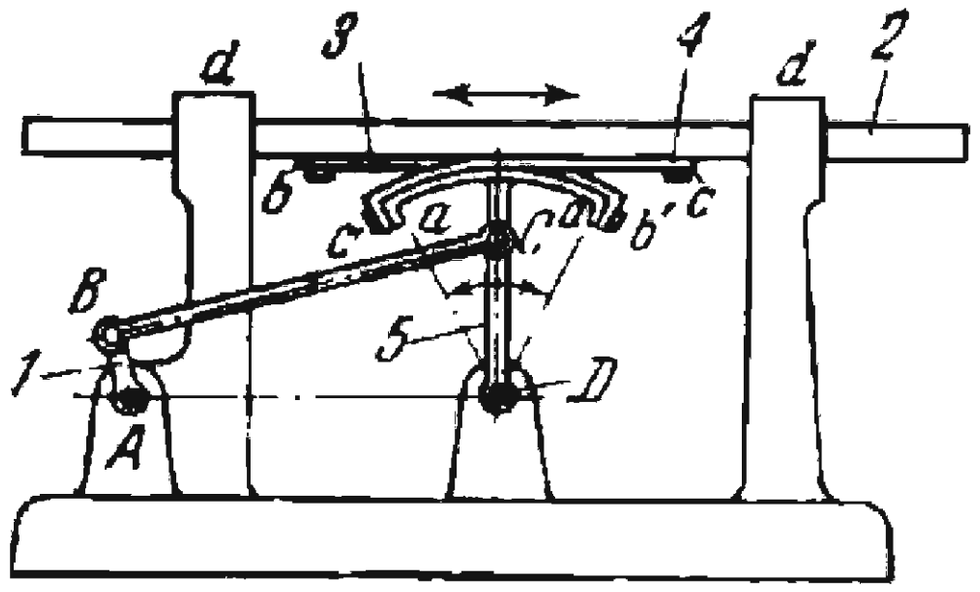


1868	SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK	FL 6L



Flexible link *2* runs over pulleys *1*, *5*, *6* and *7* of equal diameter. Link *3* is connected by turning pair *E* to flexible link *2* and by turning pair *F* to slider *4* which moves along fixed guide *a* with its axis parallel to lines *AB* and *CD*. When point *E* travels along the horizontal straight portions of its path, the velocities of points *E* and *F* are equal, i.e. link *3* has translational motion. When point *E* travels along the circular portions of its path, the motions of links *3* and *4* are equivalent to those of a slider-crank mechanism in which the length of the crank equals the radius of the pulleys.

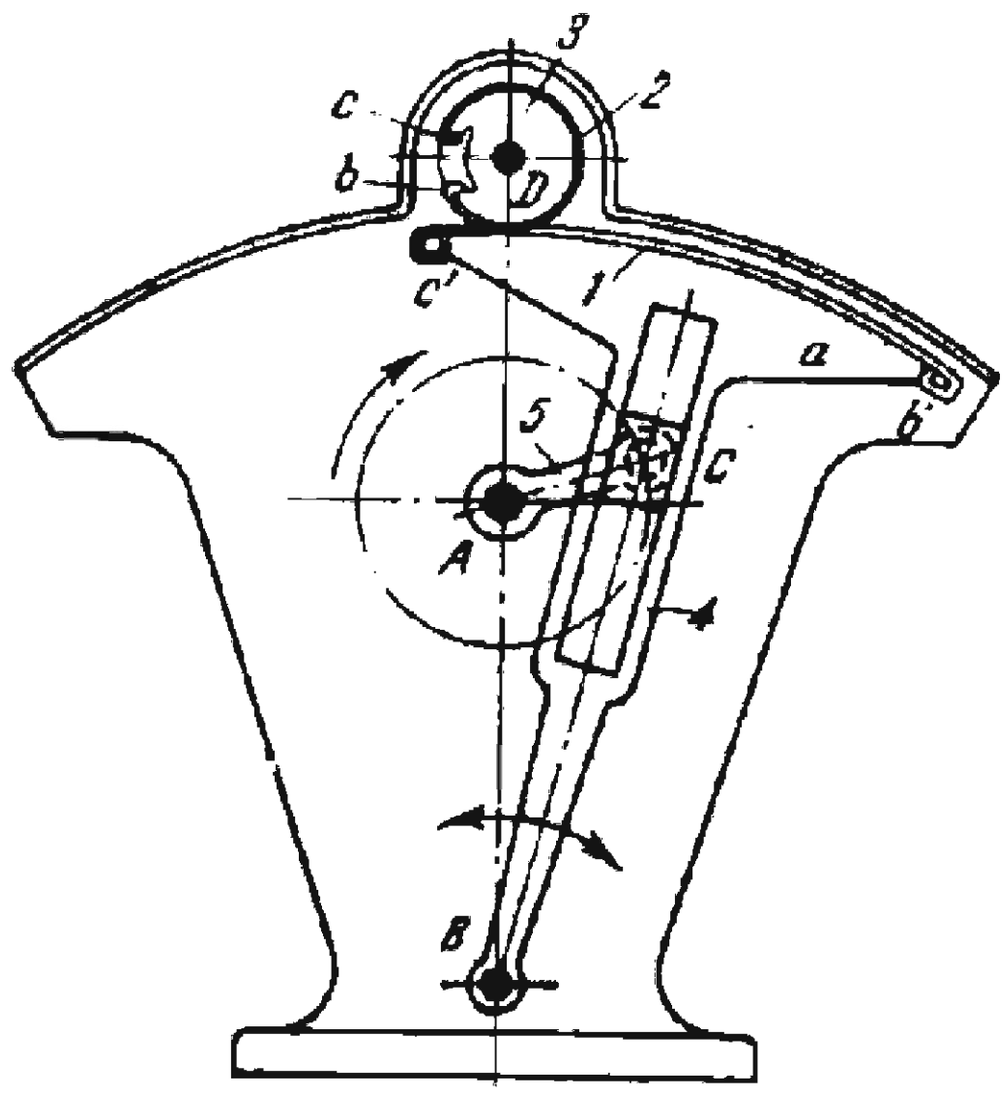
1869	LINKWORK MECHANISM CONNECTED BY FLEXIBLE LINKS TO A SLIDER	FL 6L



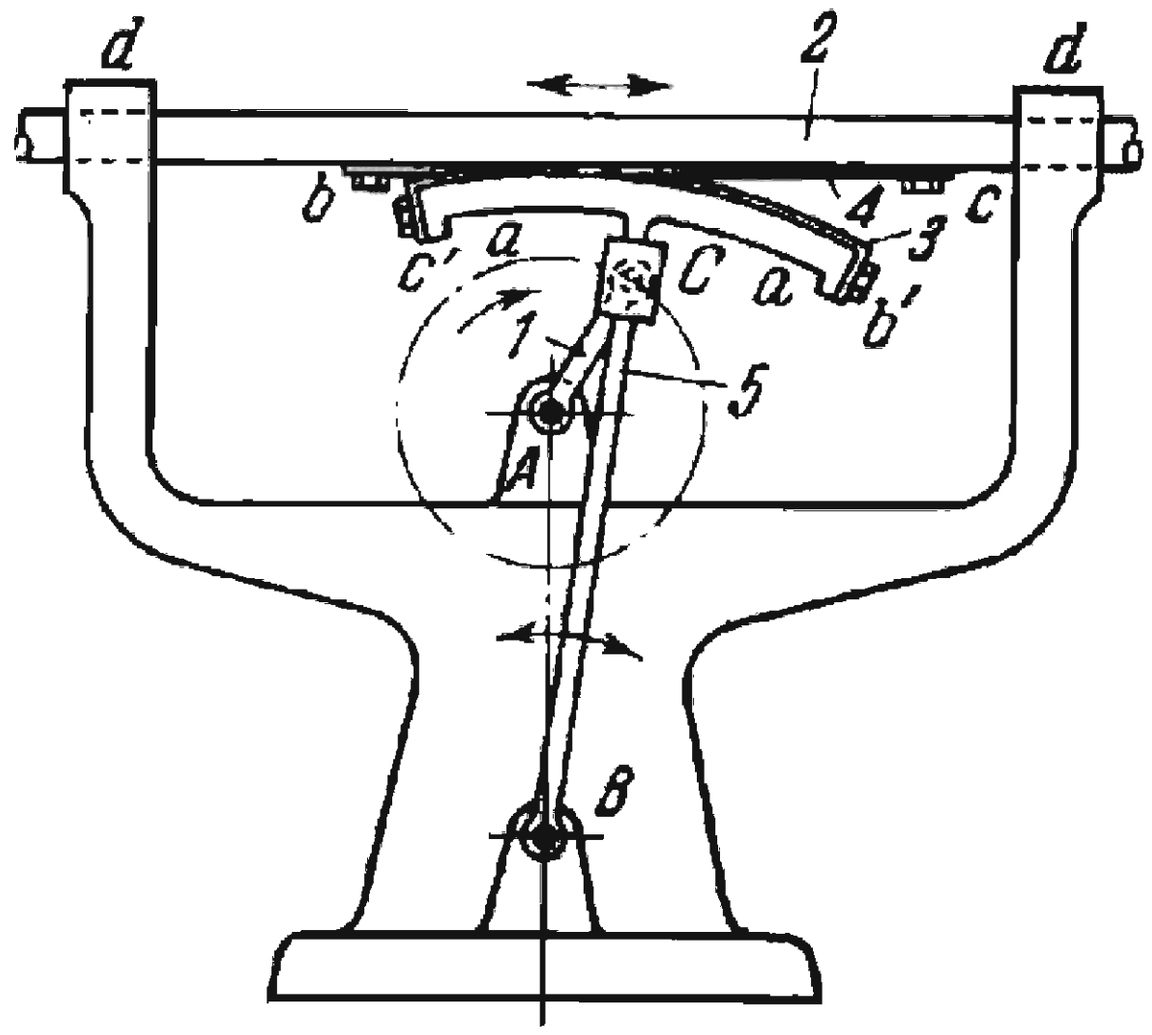
Link *5* of four-bar linkage *ABCD* has circular segment *a-a*. Steel tapes *3* and *4* are attached by their ends *b* and *c* to slider *2*. Ends *b'* and *c'* of these tapes are attached to segment *a-a*. When crank *1* rotates about fixed axis *A*, slider *2* is reciprocated in fixed guides *d-d*.

1870	LINK-GEAR MECHANISM WITH FLEXIBLE LINKS	FL 6L

Slotted link *4* has circular segment *a*. Pulley *3* is keyed on shaft *D*. Steel tapes *1* and *2* are attached by their ends *b* and *c* to pulley *3* and by their other ends *b'* and *c'* to segment *a*. When crank *5* of link-gear mechanism *ACB* rotates about fixed axis *A*, shaft *D*, on which pulley *3* is keyed, rotates alternately in both directions.

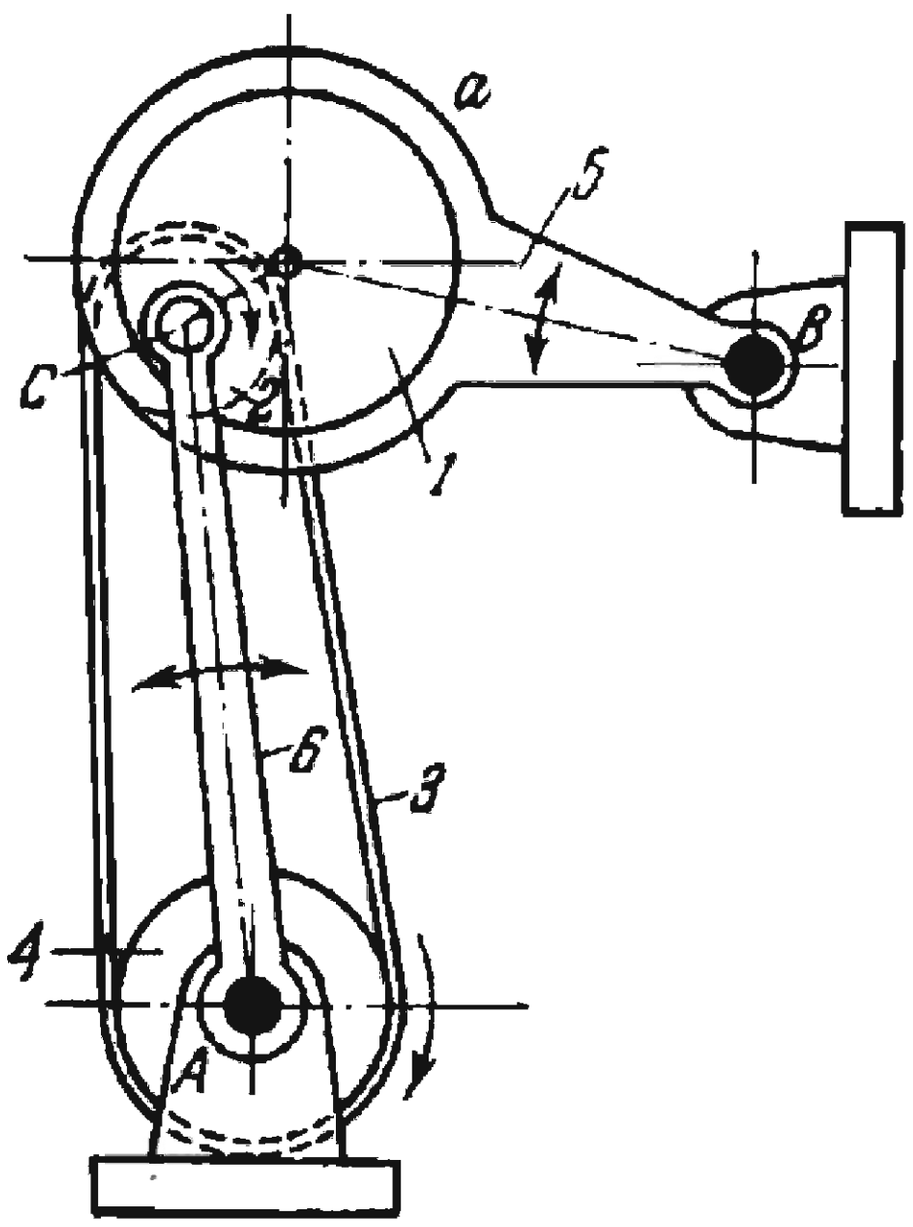


1871	LINK-GEAR MECHANISM WITH FLEXIBLE LINKS	FL 6L



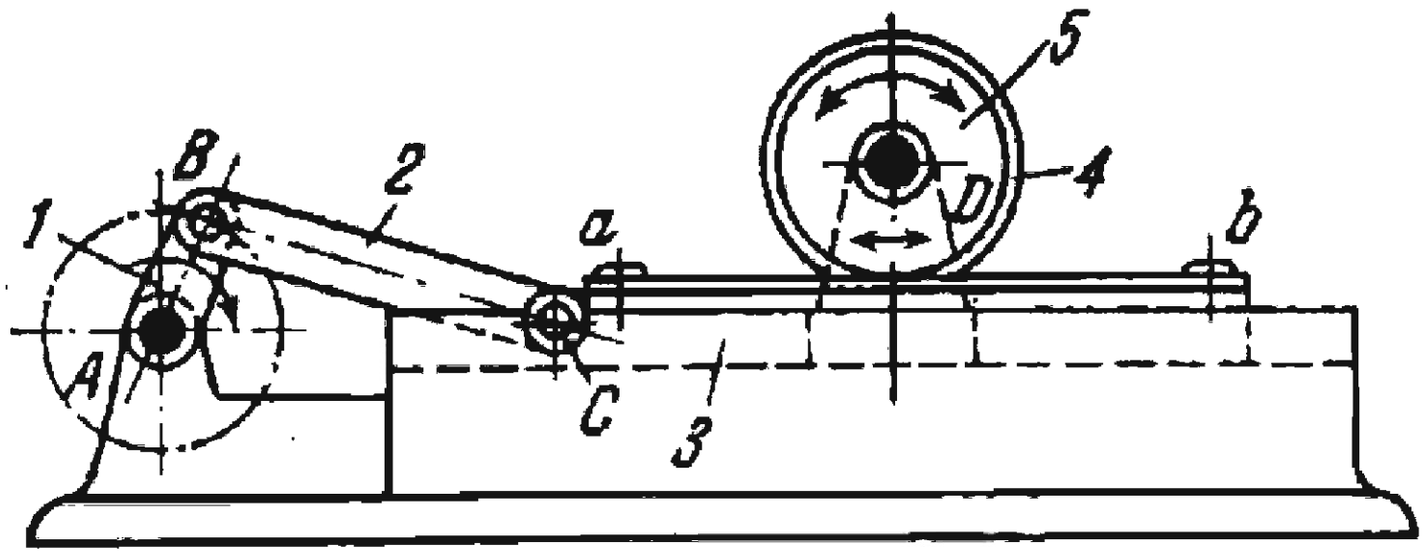
Sliding link *5* has circular segment *a-a*. Steel tapes *3* and *4* are attached by their ends *b* and *c* to slider *2* and by their other ends *b'* and *c'* to segment *a-a*. When crank *1* of link-gear mechanism *ACB* rotates about fixed axis *A*, slider *2* is reciprocated in fixed guides *d-d*.

1872	ECCENTRIC-TYPE LEVER MECHANISM WITH A FLEXIBLE LINK	FL 6L



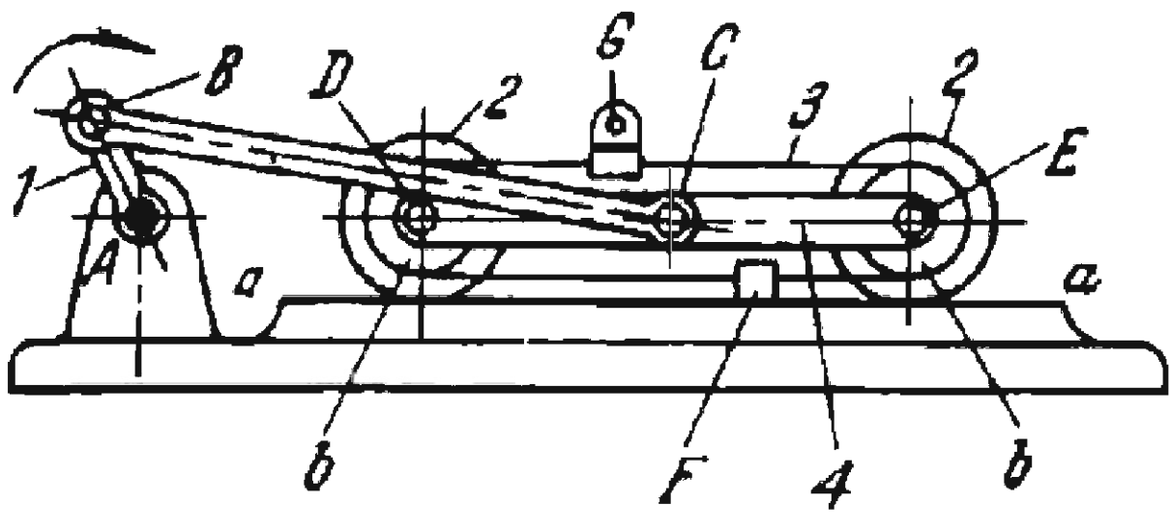
Link *5* has collar *a* encircling round eccentric *1* which is rigidly attached to pulley *2* having its centre at point *C*. Pulley *2* (and eccentric *1*) is driven through flexible link *3* from driving pulley *4*. At this, links *5* and *6* oscillate about fixed axes *B* and *A*.

1873	SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK	FL 6L



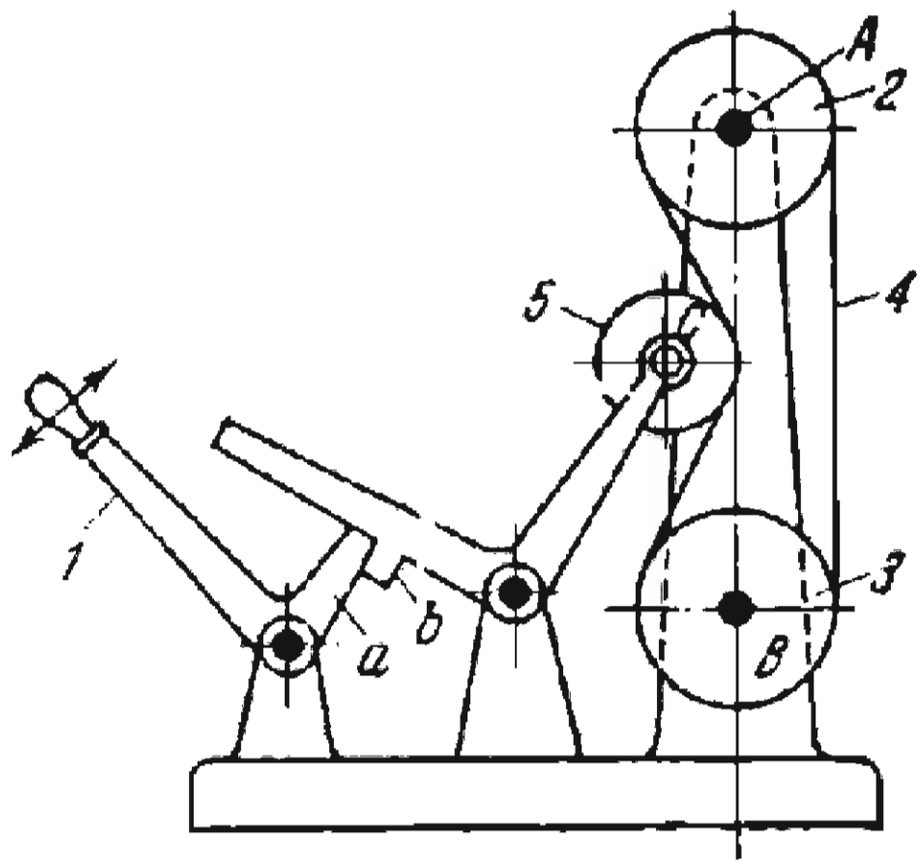
Slider-crank linkage ABC reciprocates slider *3* to which the ends a and b of flexible link *4* are attached. Link *4* runs around pulley *5* which rotates about fixed axis D. Thus rotation of crank *1* about fixed axis A is converted into alternating rotation of pulley *5* and shaft D in both directions.

1874	SLIDER-CRANK CRAWLER MECHANISM WITH A FLEXIBLE LINK	FL 6L



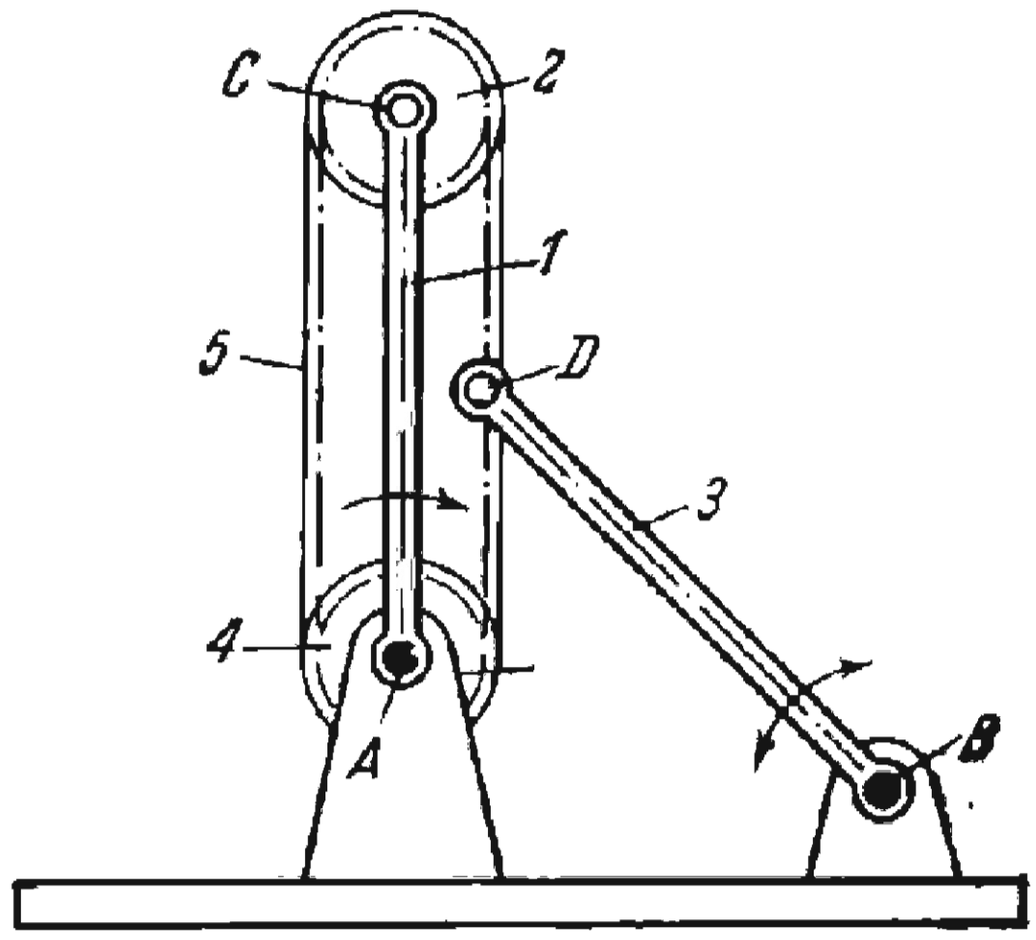
Slider-crank linkage ABC reciprocates link *4* which is connected by turning pairs D and E to rollers *2*, rolling without slipping along plane a-a. Flexible link *3* runs over pulleys b which turn freely about axes D and E of rollers *2*. Flexible link *3* is rigidly attached to the base at point F. In one revolution of crank *1* about fixed axis A, point G of link *3* travels a distance of $s = 4\overline{AB}$.

1875	LEVER-TYPE IDLER PULLEY MECHANISM	FL 6L



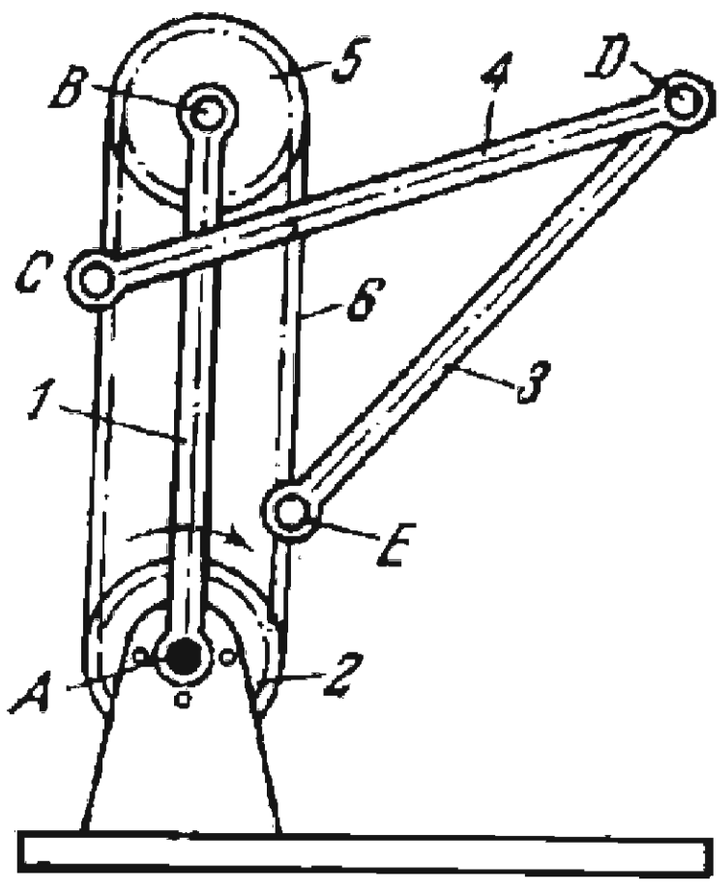
Flexible link *4*, running over pulleys *2* and *3*, is tensioned by idler pulley *5* when lever *1* is turned to the position shown. The location of stops *a* and *b* enables lever *1* to be locked in this position.

1876	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



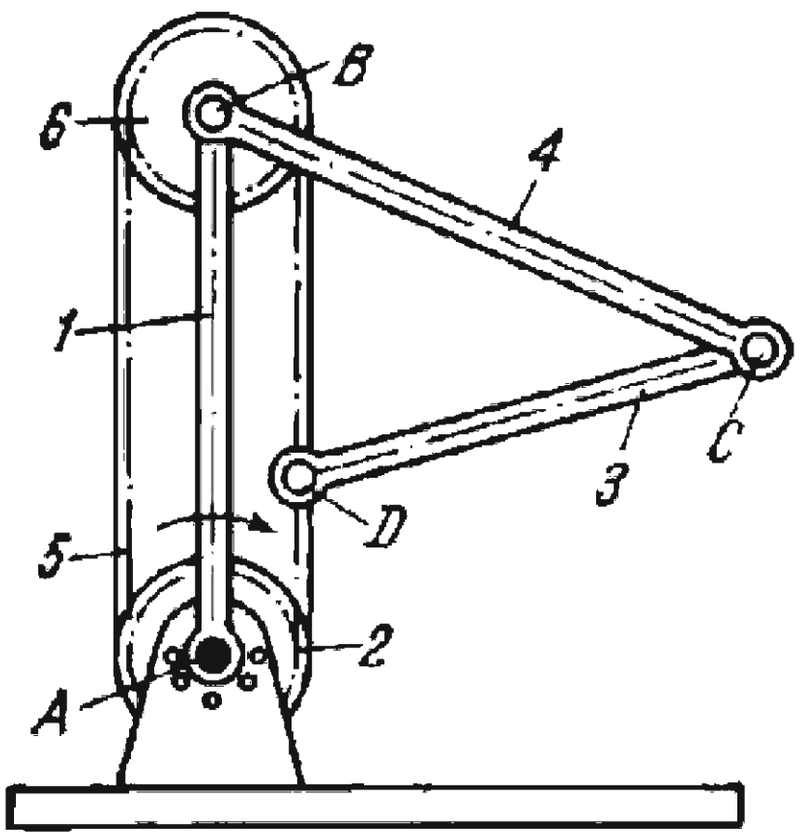
Link *1* turns about fixed axis *A* and is connected by turning pair *C* to pulley *2*. Flexible link *5* runs over pulleys *2* and *4*, of equal diameter, which rotate about axes *C* and *A*. Link *3* turns about fixed axis *B* and is connected by turning pair *D* to flexible link *5*. When link *1* turns about axis *A*, link *3* oscillates about axis *B*.

1877	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



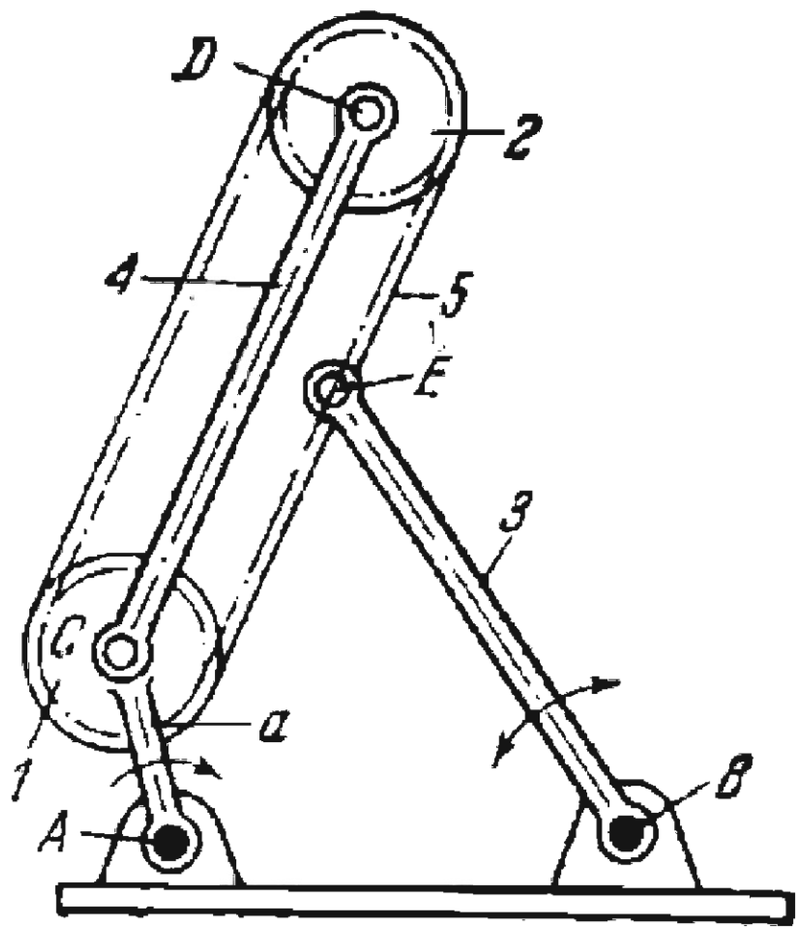
Link *1* turns about fixed axis *A* and is connected by turning pair *B* to pulley *5*. Flexible link *6* runs over pulleys *5* and *2*, of equal diameter, the latter being rigidly attached to the base. Links *3* and *4* are connected together by turning pair *D* and to flexible link *6* by turning pairs *E* and *C*. When link *1* turns about axis *A*, links *3* and *4* have complex motions.

1878	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



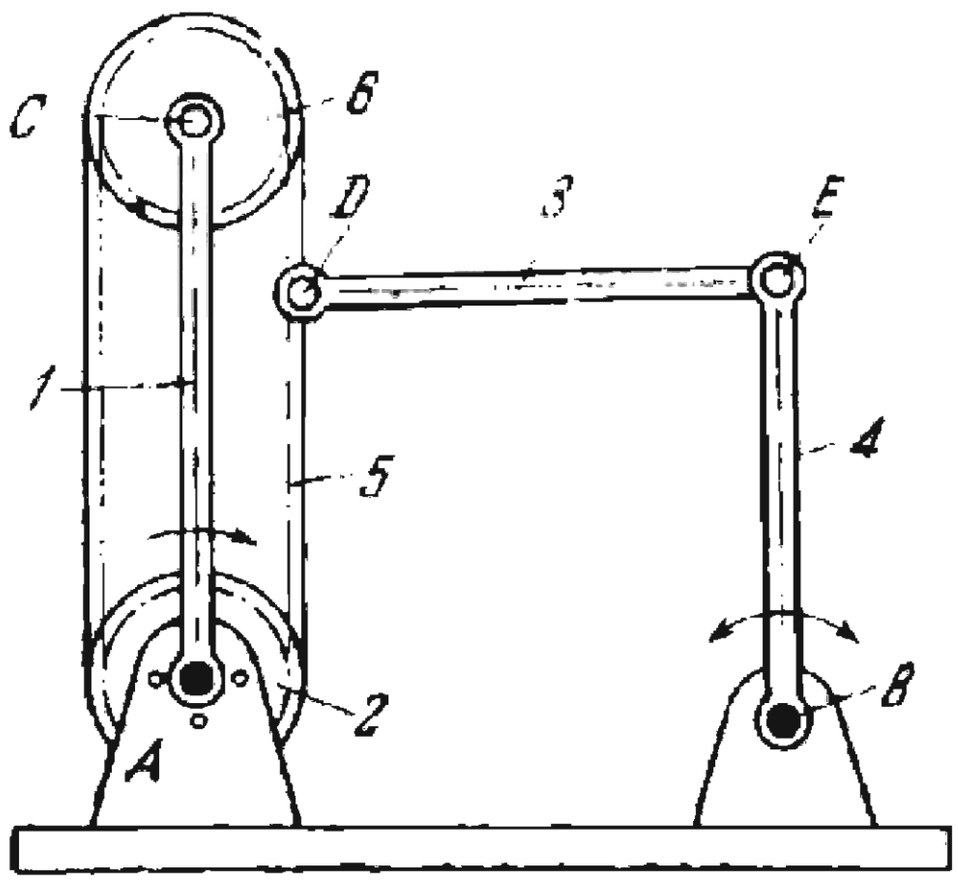
Link *1* turns about fixed axis *A* and is connected by turning pairs *B* to pulley *6* and link *4*. Flexible link *5* runs over pulleys *6* and *2*, of equal diameter, the latter being rigidly attached to the base. Link *3* is connected by turning pairs *C* and *D* to link *4* and flexible link *5*. When link *1* turns about axis *A*, links *3* and *4* have complex motions.

1879	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



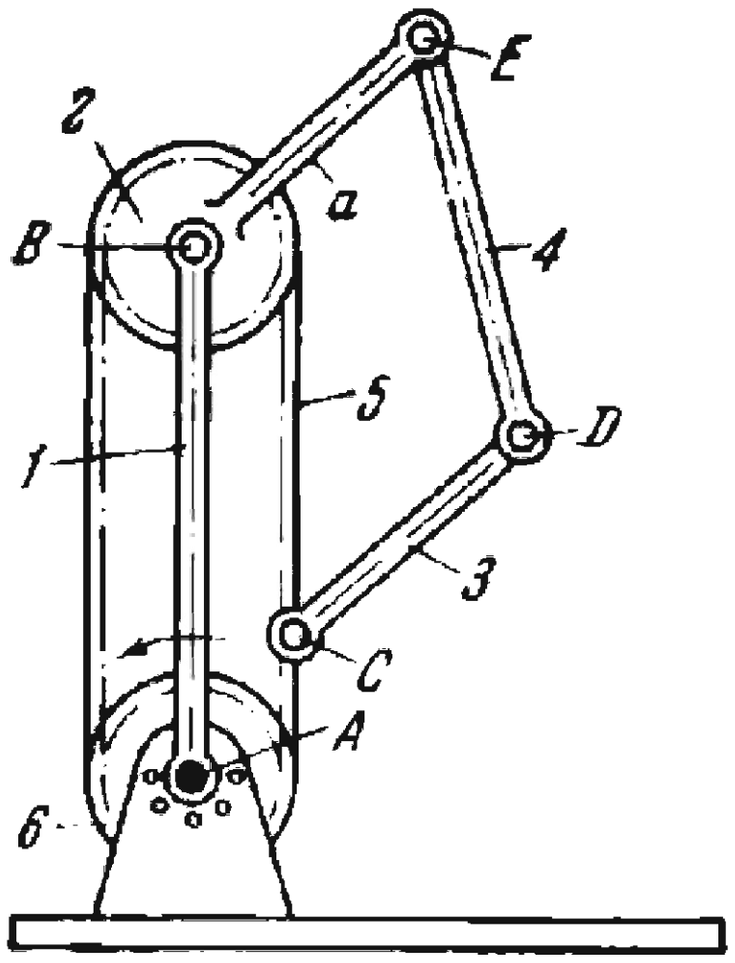
Pulley *1* has extension *a* with which it turns about fixed axis *A*. Link *4* is connected by turning pairs *C* and *D* to pulleys *1* and *2*, of equal diameter. Flexible link *5* runs over pulleys *1* and *2* and is connected by turning pair *E* to link *3* which turns about fixed axis *B*. When pulley *1* turns about axis *A*, link *3* oscillates about axis *B*.

1880	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



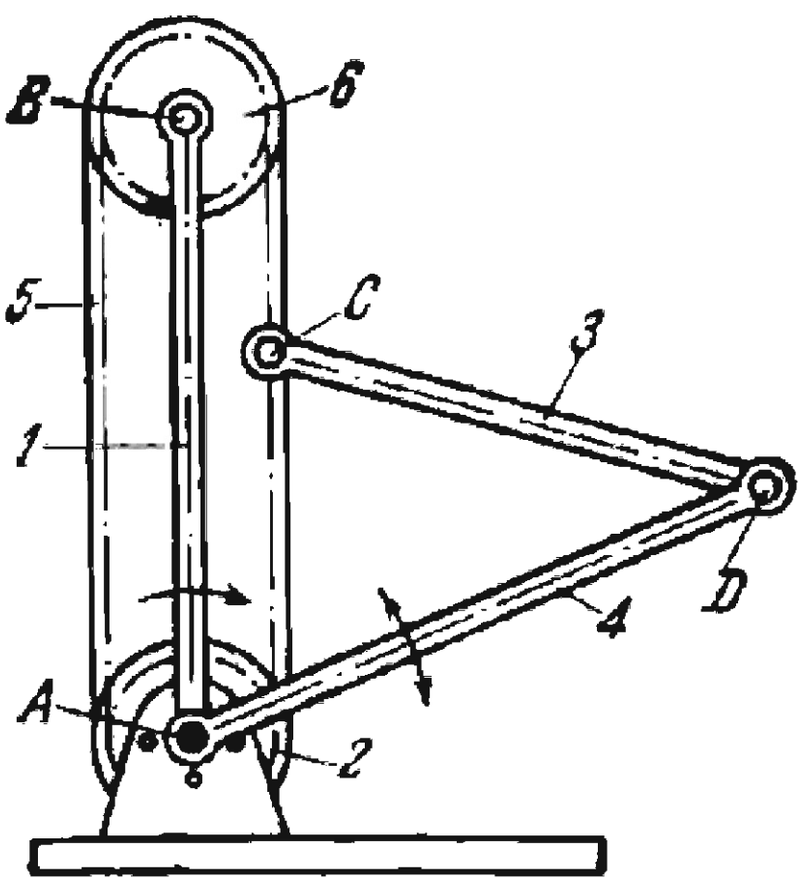
Link *1* turns about fixed axis *A* and is connected by turning pair *C* to pulley *6*. Flexible link *5* runs over pulleys *6* and *2*, of equal diameter, the latter being rigidly attached to the base. Link *3* is connected by turning pairs *D* and *E* to flexible link *5* and to link *4* which turns about fixed axis *B*. When link *1* turns about axis *A*, link *3* has a complex motion and link *4* oscillates about axis *B*.

1881	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



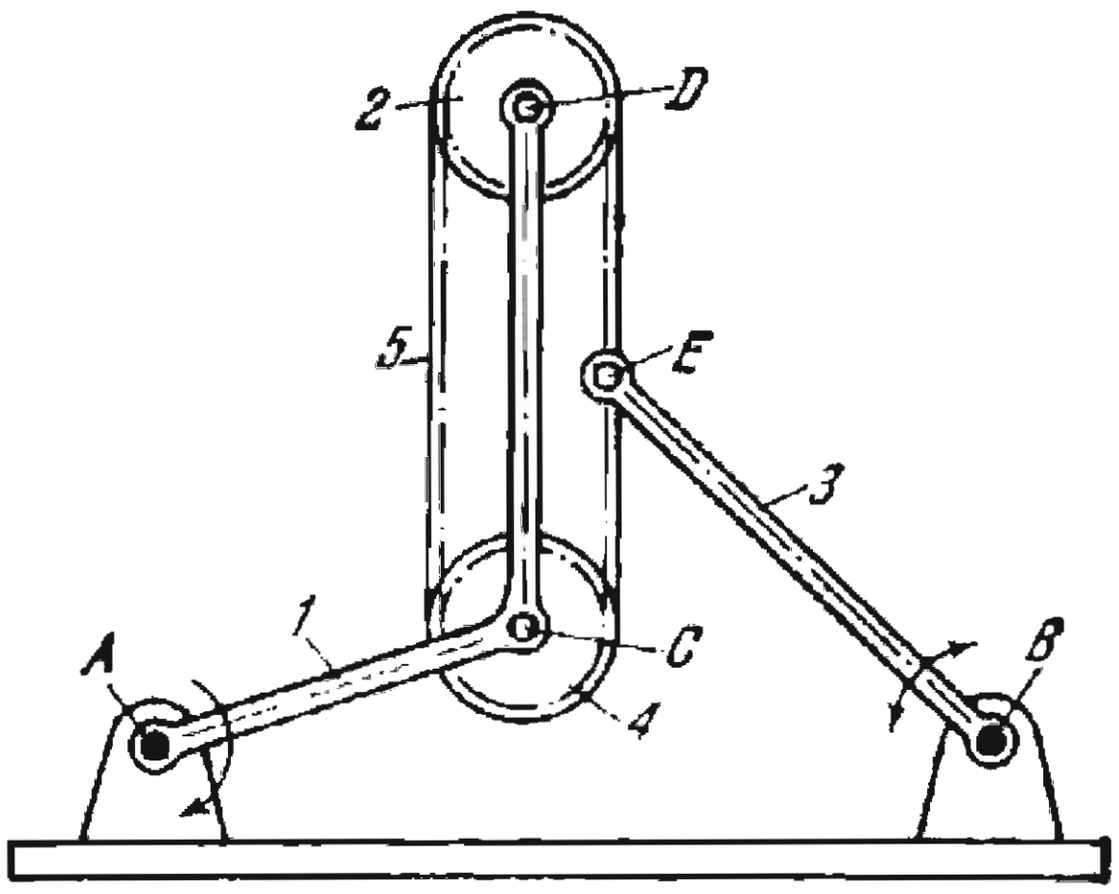
Link *1* turns about fixed axis *A* and is connected by turning pair *B* to pulley *2*. Flexible link *5* runs over pulleys *2* and *6*, of equal diameter, the latter being rigidly attached to the base. Link *3* is connected by turning pairs *C* and *D* to flexible link *5* and to link *4* which, in turn, is connected by turning pair *E* to extension *a* of pulley *2*. When link *1* turns about axis *A*, links *3* and *4* have complex motions.

1882	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



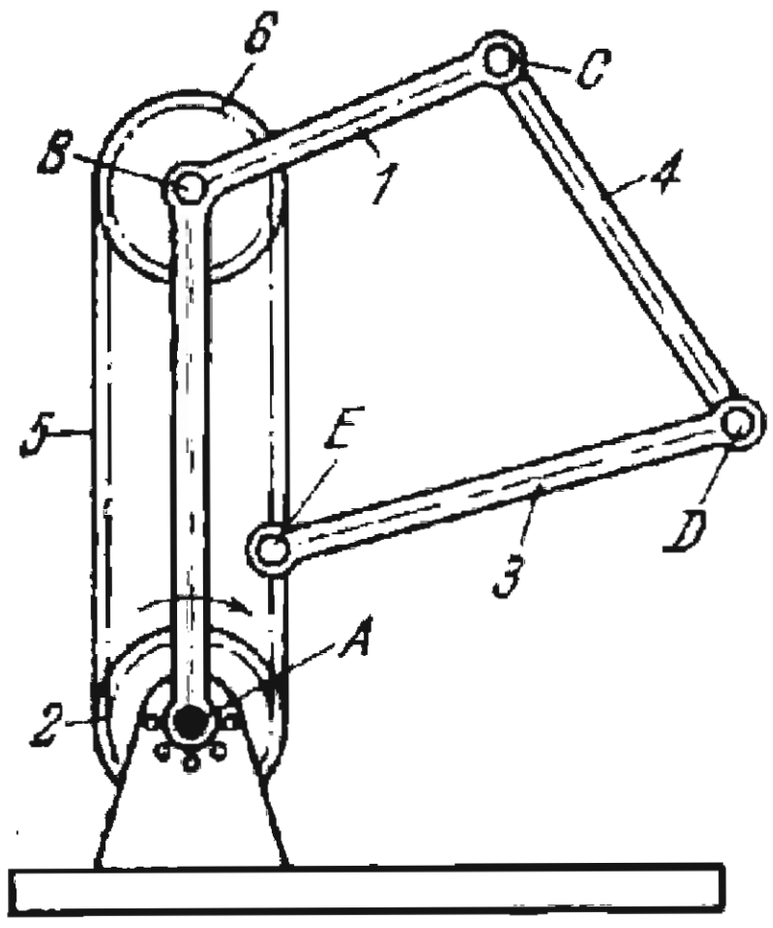
Link *1* turns about fixed axis *A* and is connected by turning pair *B* to pulley *6*. Flexible link *5* runs over pulleys *6* and *2*, of equal diameter, the latter being rigidly attached to the base. Link *3* is connected by turning pairs *C* and *D* to flexible link *5* and to link *4* which turns about axis *A*. When link *1* turns about axis *A*, link *3* has a complex motion and link *4* oscillates about axis *A*.

1883	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



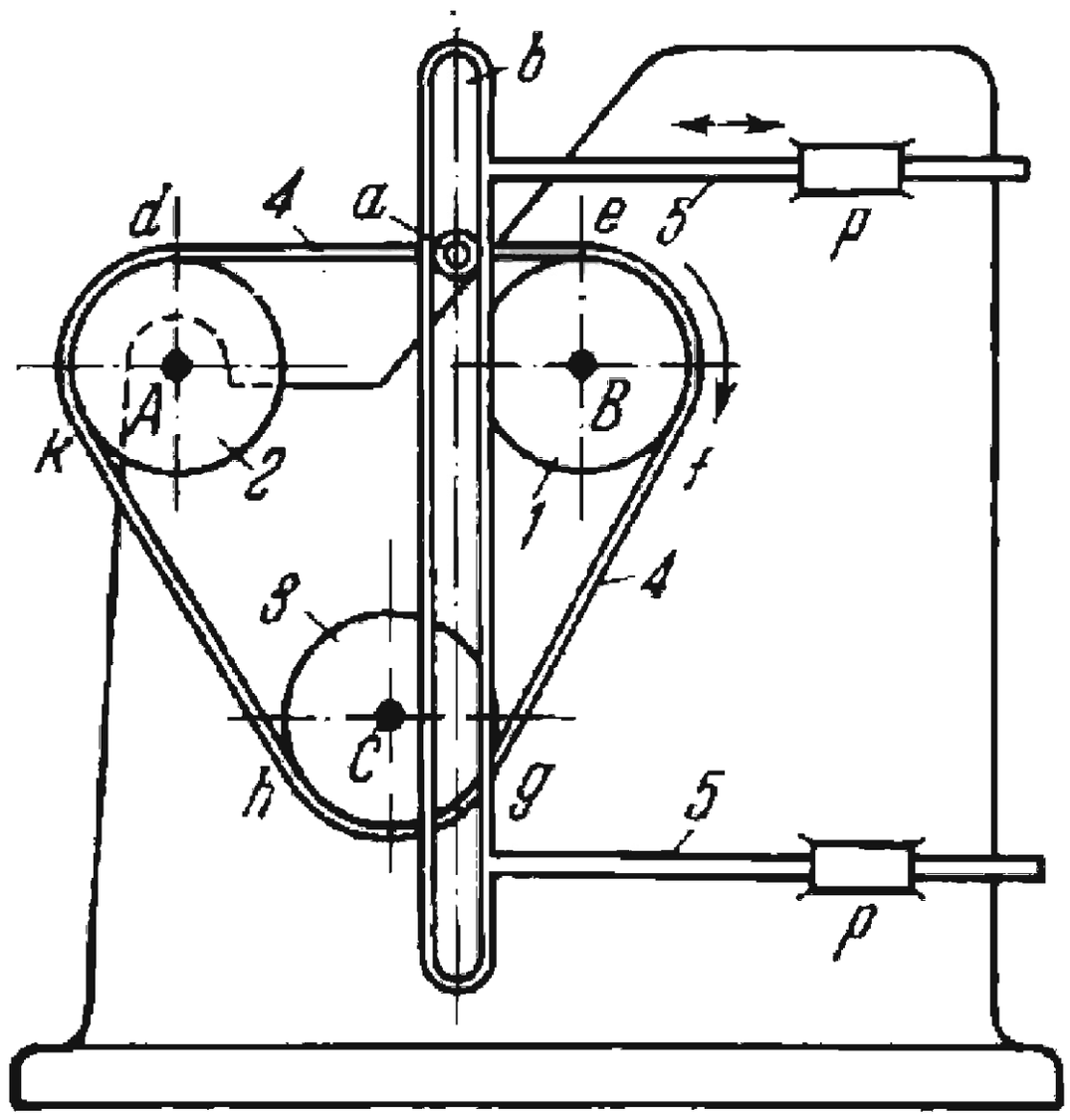
Link *1* turns about fixed axis *A* and is connected by turning pairs *C* and *D* to pulleys *4* and *2*. Flexible link *5* runs over pulleys *2* and *4*, of equal diameter, and is connected by turning pair *E* to link *3* which turns about fixed axis *B*. When link *1* turns about axis *A*, link *3* oscillates about axis *B*.

1884	HAIN LEVER-TYPE SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL 6L



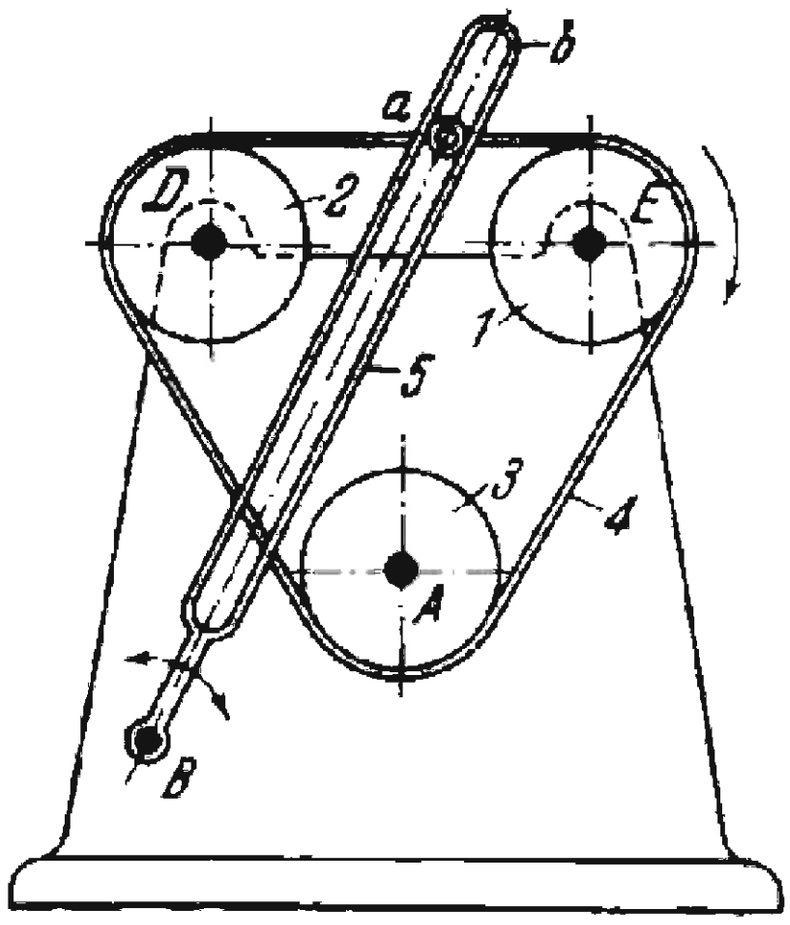
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *6* and link *4*. Flexible link *5* runs over pulleys *6* and *2*, of equal diameter, the latter being rigidly attached to the base. Link *3* is connected by turning pairs *D* and *E* to link *4* and flexible link *5*. When link *1* turns about axis *A*, links *3* and *4* have complex motions.

1885	SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK	FL 6L



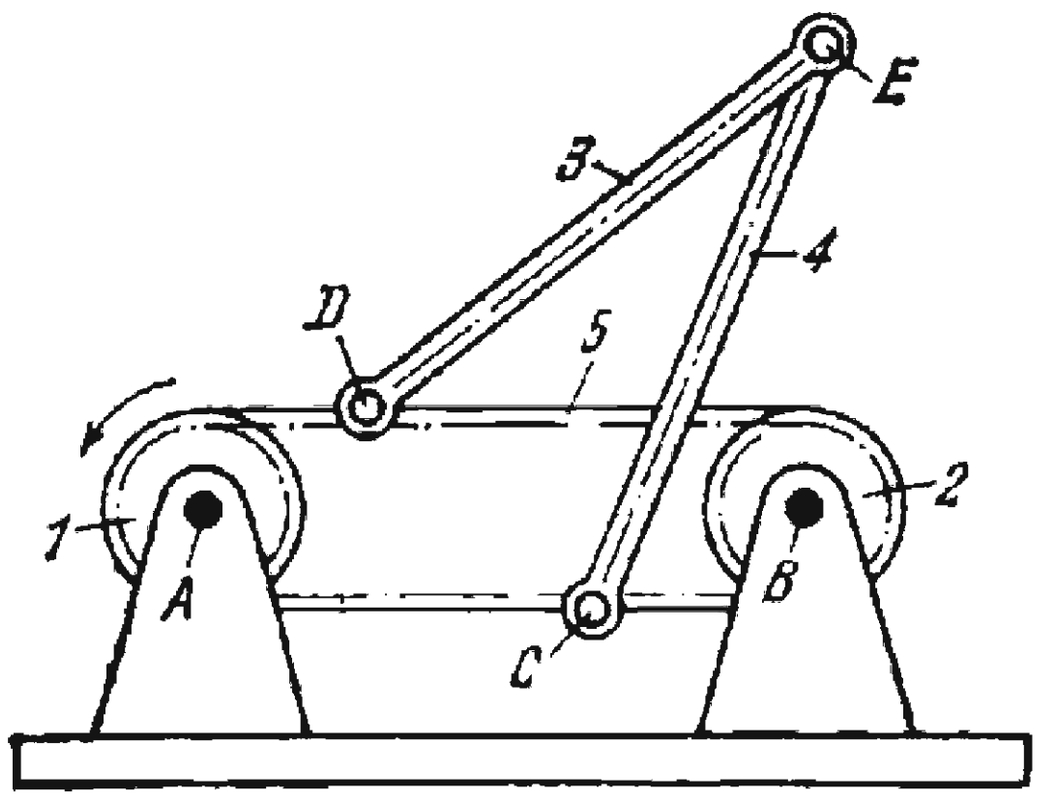
The lengths of the links comply with the conditions: $r_1 = r_2 = r_3$, where r_1, r_2 and r_3 are the radii of pulleys *1*, *2* and *3*, and $\overline{AB} = \overline{BC} = \overline{CA}$. Pulley *1* rotates about fixed axis *B* and, through flexible link *4*, rotates pulleys *2* and *3* about fixed axes *A* and *C*. Pin *a* of flexible link *4* slides along slot *b* of slider *5* which moves in fixed guides *p-p*. When pulley *1* rotates about axis *B*, slider *5* reciprocates in guides *p-p*. If line *AB* is parallel to the axes of guides *p-p* and pulley *1* rotates at constant angular velocity ω_1, then, when pin *a* travels along straight portions *de*, *fg* and *hk* of its path, slider *5* travels with a constant velocity equal to $v = \omega_1 r_1$ for portion *de*, and $v' = \frac{\omega_1 r_1}{2}$ for portions *fg* and *hk*.

1886	LINK-GEAR MECHANISM WITH A FLEXIBLE LINK	FL 6L



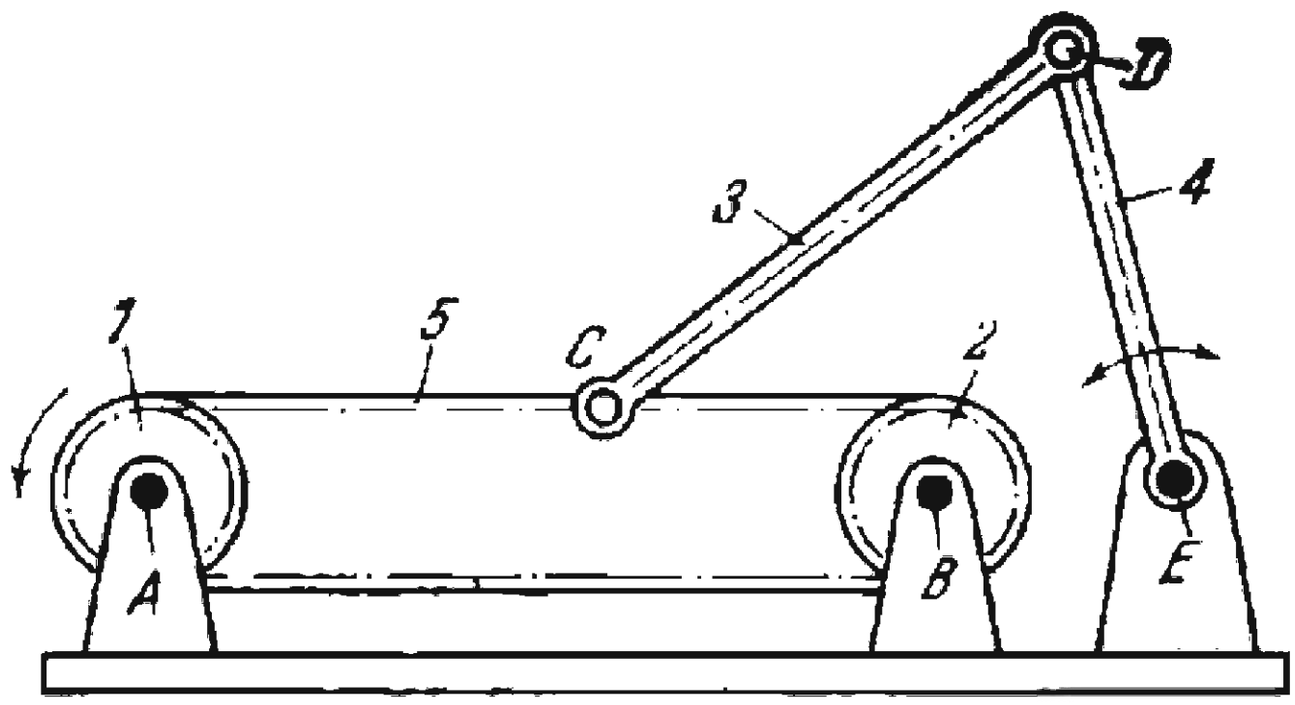
Pulley *1* rotates about fixed axis *E* and, through flexible link *4*, rotates pulleys *2* and *3* about fixed axes *D* and *A*. Pin *a* of flexible link *4* slides along slot *b* of slotted lever *5* which turns about fixed axis *B*. When pulley *1* rotates about axis *E*, lever *5* oscillates about axis *B*. The law of motion of slotted lever *5* per cycle of the mechanism can be varied by changing the diameters of pulleys *1*, *2* and *3* and the location of their axes of rotation.

1887	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK	FL 6L



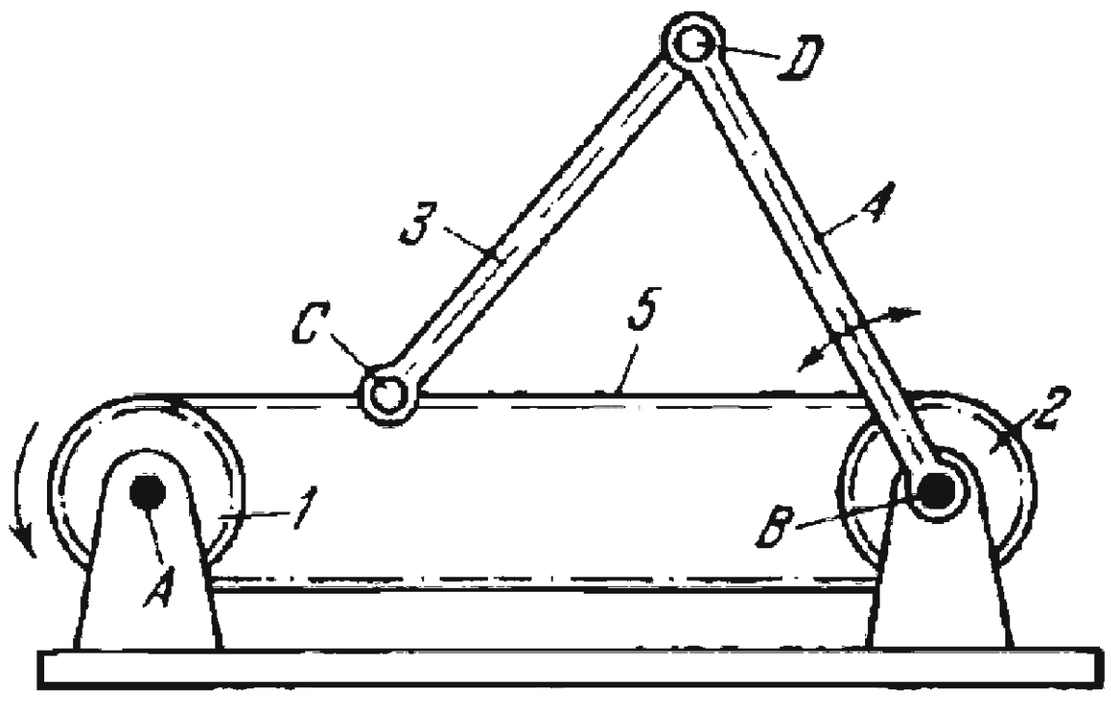
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* about fixed axis *B*. Links *3* and *4* are connected together by turning pair *E* and to flexible link *5* by turning pairs *D* and *C*. When pulley *1* rotates about axis *A*, links *3* and *4* have complex motions.

1888	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK	FL 6L



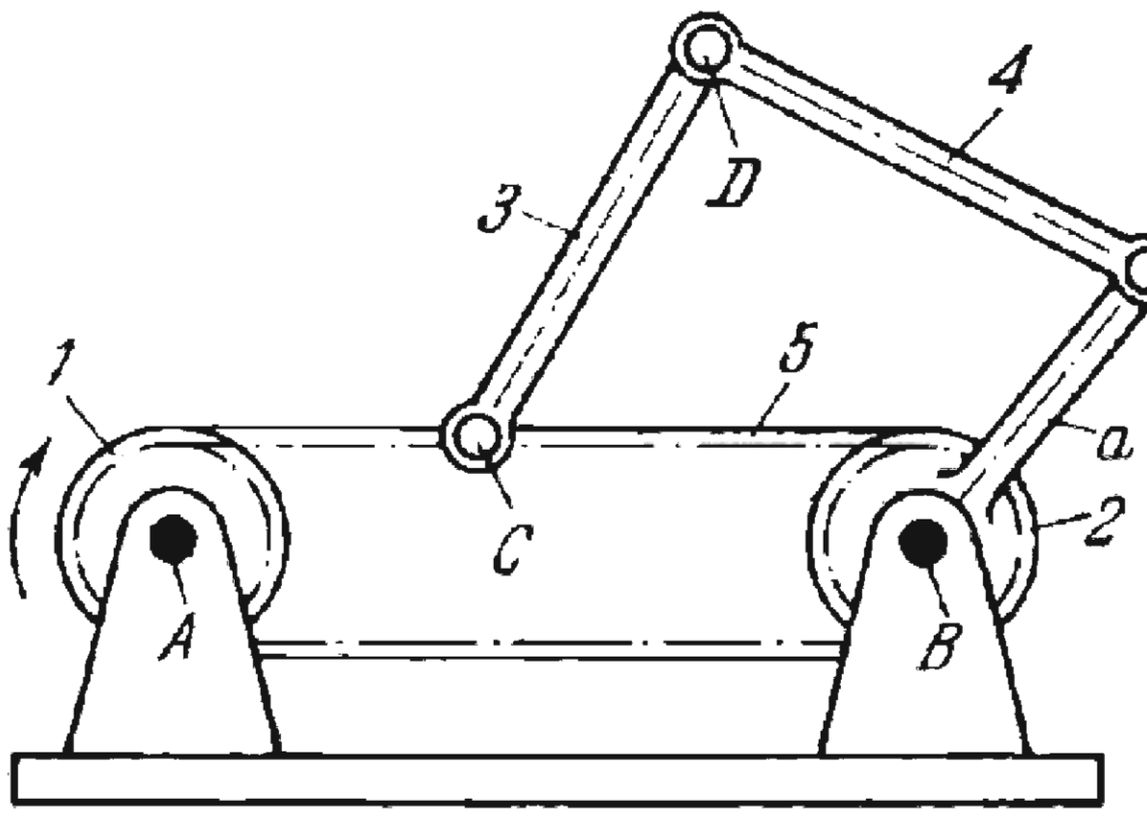
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* about fixed axis *B*. Link *3* is connected by turning pairs *C* and *D* to flexible link *5* and to link *4* which turns about fixed axis *E*. When pulley *1* rotates about axis *A*, link *3* has a complex motion and link *4* oscillates about axis *E*.

1889	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK	Fl. 6L



Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* about fixed axis *B*. Link *3* is connected by turning pairs *C* and *D* to flexible link *5* and to link *4* which turns about axis *B*. When pulley *1* rotates about axis *A*, link *3* has a complex mot on and link *4* oscillates about axis *B*.

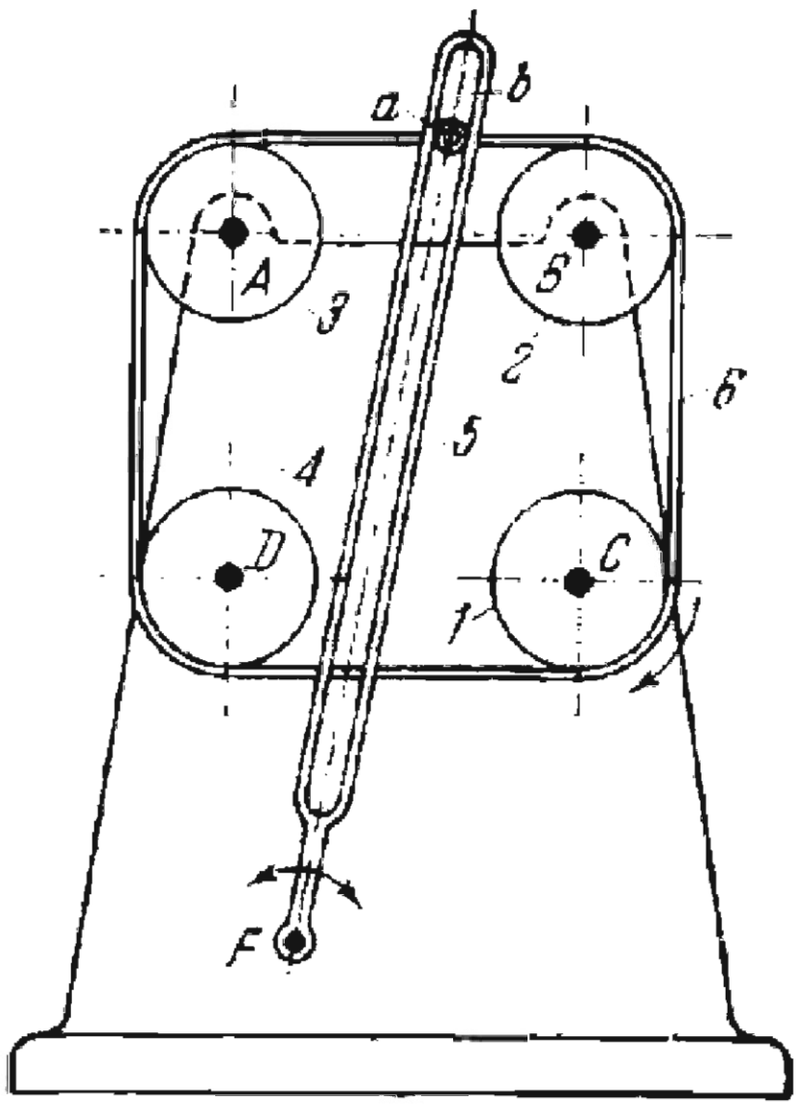
1890	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK	FL 6L



Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* with extension *a* about fixed axis *B*. Link *3* is connected by turning pairs *C* and *D* to flexible link *5* and to link *4* which is connected, in turn, by turning pair *E* to extension *a* of pulley *2*. When pulley *1* rotates about axis *A*, links *3* and *4* have complex motions.

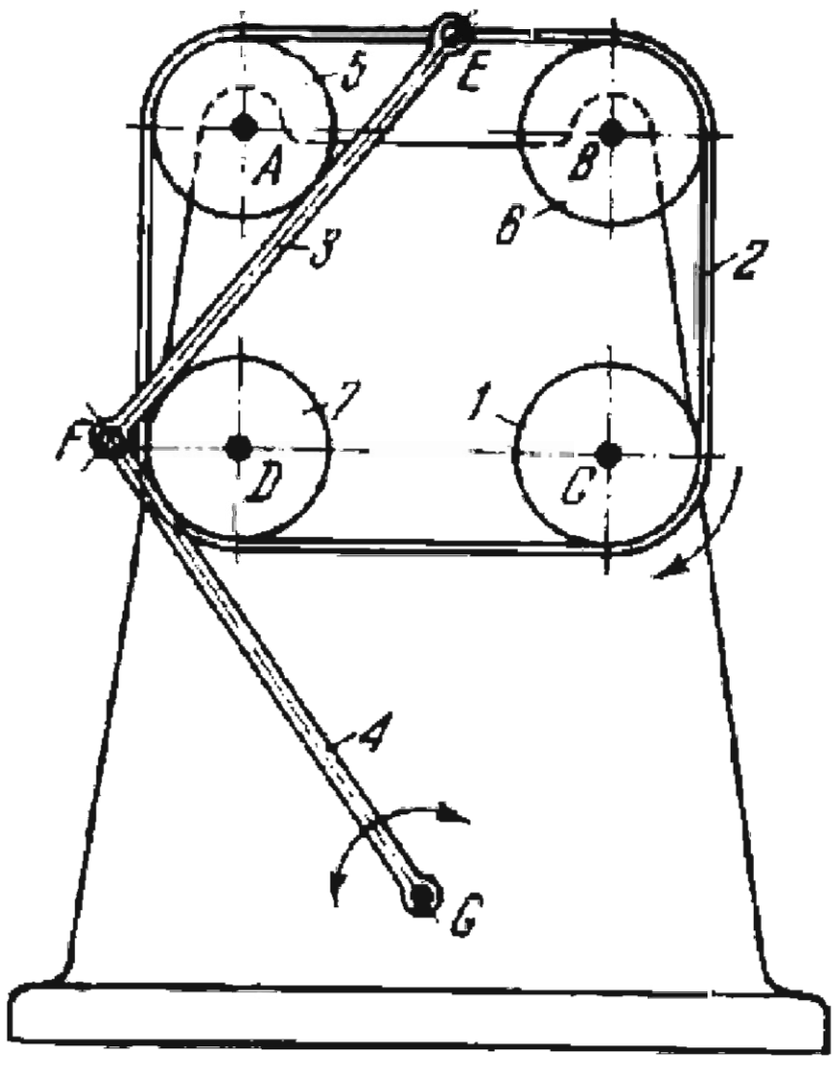
4. GENERAL-PURPOSE MULTIPLE-LINK MECHANISMS (1891 through 1920)

1891	LINK-GEAR MECHANISM WITH A FLEXIBLE LINK	FL ML



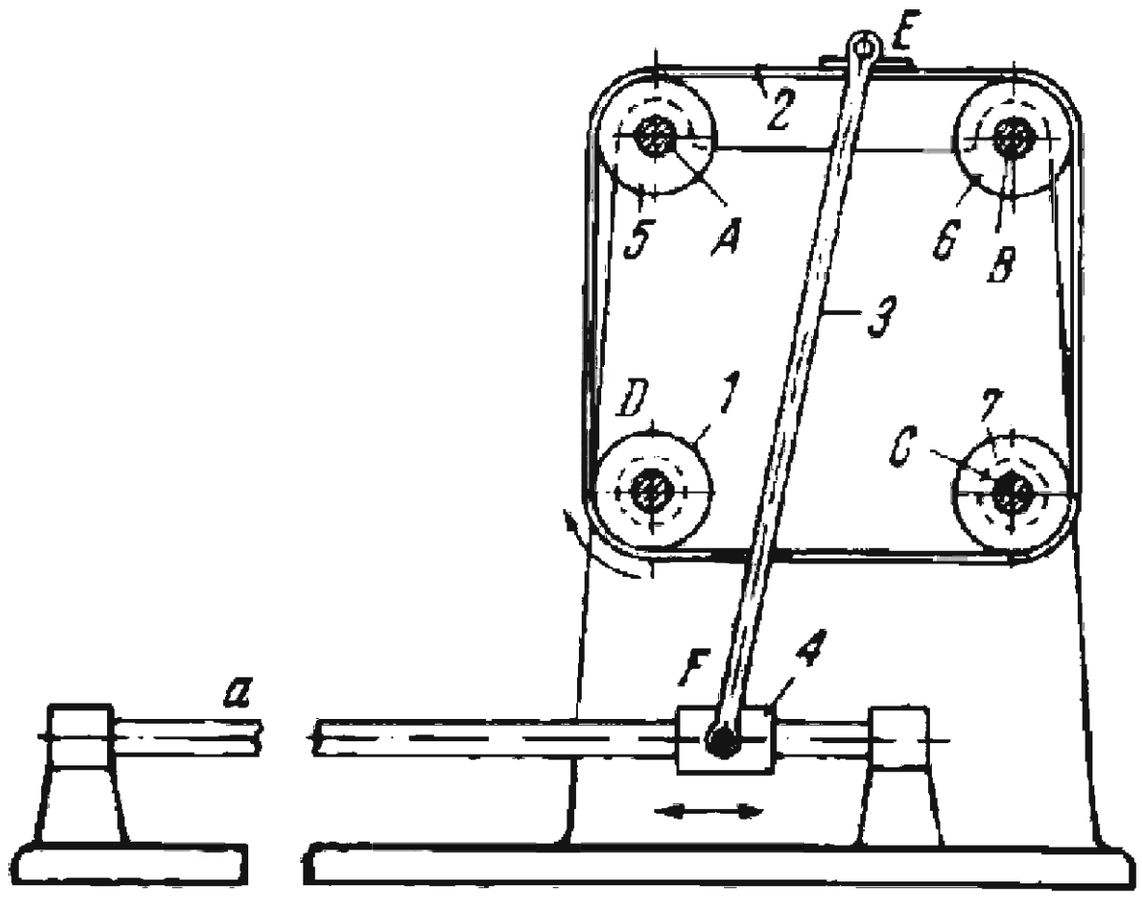
Pulley *1* rotates about fixed axis *C* and, through flexible link *6*, rotates pulleys *2*, *3* and *4* about fixed axes *B*, *A* and *D*. Pin *a* of flexible link *6* slides along slot *b* of slotted lever *5* which turns about fixed axis *F*. When pulley *1* rotates about axis *C*, lever *5* oscillates about axis *F*. The law of motion of slotted lever *5* per cycle of the mechanism can be varied by changing the diameters of pulleys *1*, *2*, *3* and *4* and the location of their axes of rotation.

1892	LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



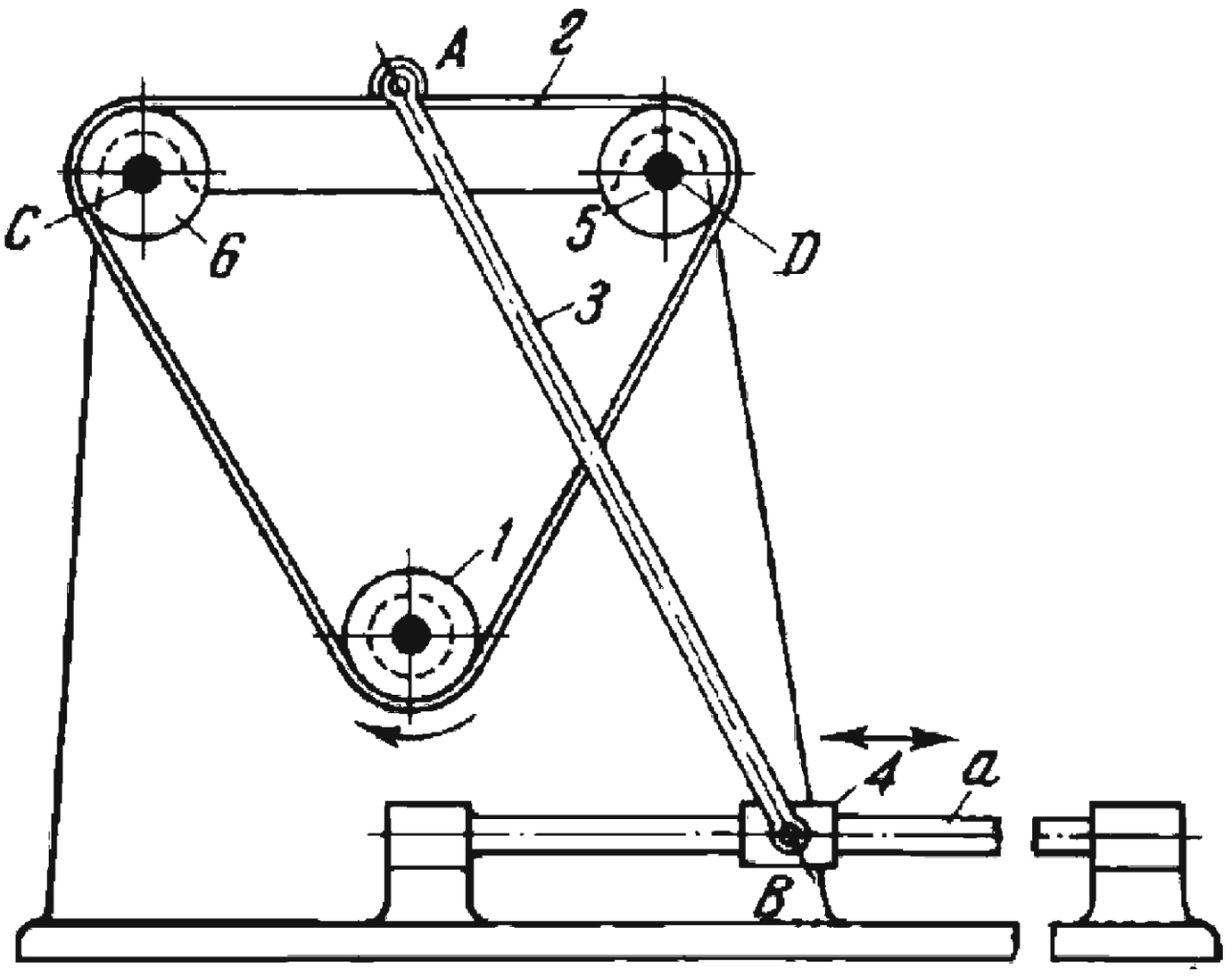
Pulley *1* rotates about fixed axis *C* and, through flexible link *2*, rotates pulleys *5*, *6* and *7* about fixed axes *A*, *B* and *D*. Link *3* is connected by turning pairs *E* and *F* to flexible link *2* and to link *4* which turns about fixed axis *G*. When pulley *1* rotates about axis *C*, link *4* oscillates about axis *G*. The law of motion of the mechanism can be varied by changing the diameters of pulleys *1*, *5*, *6* and *7*, and the location of their axes of rotation.

SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK



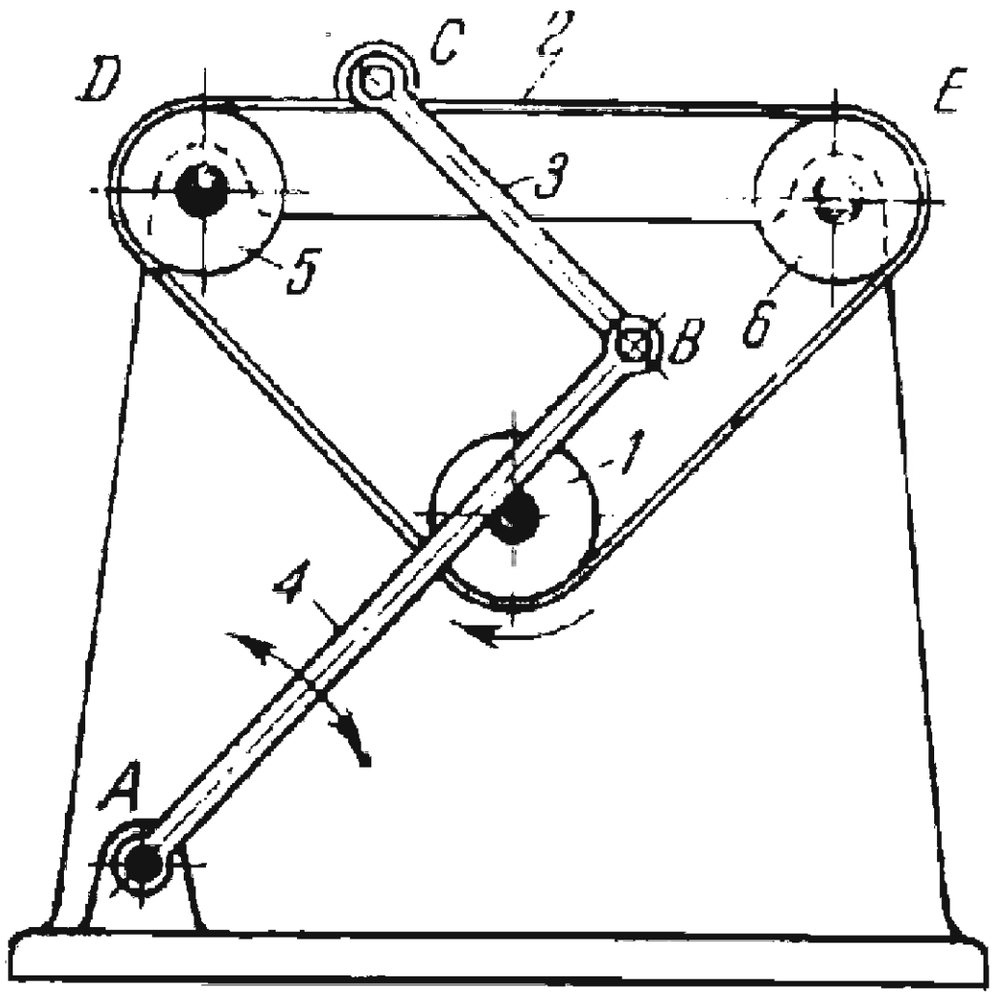
The lengths of the links comply with the condition: $\overline{AB} = \overline{BC} = \overline{CD} = \overline{DA}$. Figure $ABCD$ is a square with two sides parallel to the motion of slider *4* and the other two perpendicular to this motion. Flexible link *2* runs over pulleys *1*, *5*, *6* and *7* of equal diameter. Connecting rod *3* is connected by turning pair E to flexible link *2* and by turning pair F to slider *4* which moves along fixed guide a. When point E travels along the horizontal straight portions of its path, link *3* has translational motion. When point E travels over the vertical straight portions, the motions of links *3* and *4* are equivalent to those of the connecting rod and slider in an ellipsograph mechanism. When point E travels along the circular portions of its path, the motions of links *3* and *4* are equivalent to those of the connecting rod and slider in an offset slider-crank mechanism in which the length of the crank equals the radius of the pulleys.

SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK



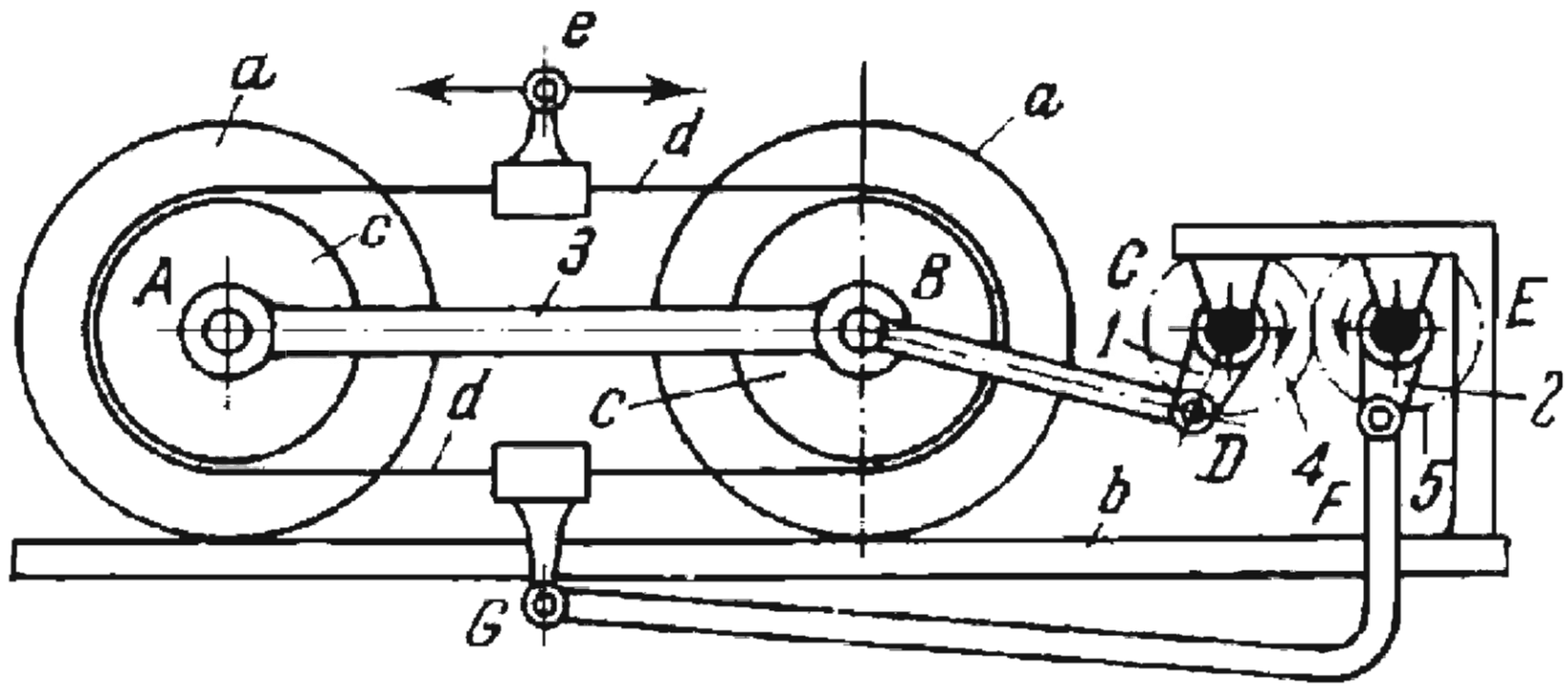
Flexible link *2* runs over pulleys *1*, *5* and *6* of equal diameter and is connected by turning pair *A* to connecting rod *3*. Link *3* is connected by turning pair *B* to slider *4* which moves along fixed guide *a* whose axis is parallel to line *CD*. When point *A* travels along the horizontal straight portion (parallel to line *CD*) of its path, link *3* has translational motion. When point *A* travels along the inclined straight portions, the motions of links *3* and *4* are equivalent to those of the connecting rod and slider in an ellipsograph mechanism. When point *A* travels along the circular portions of its path, the motions of links *3* and *4* are equivalent to those of the connecting rod and slider in an offset slider-crank mechanism in which the length of the crank equals the radius of the pulleys.

1895	LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



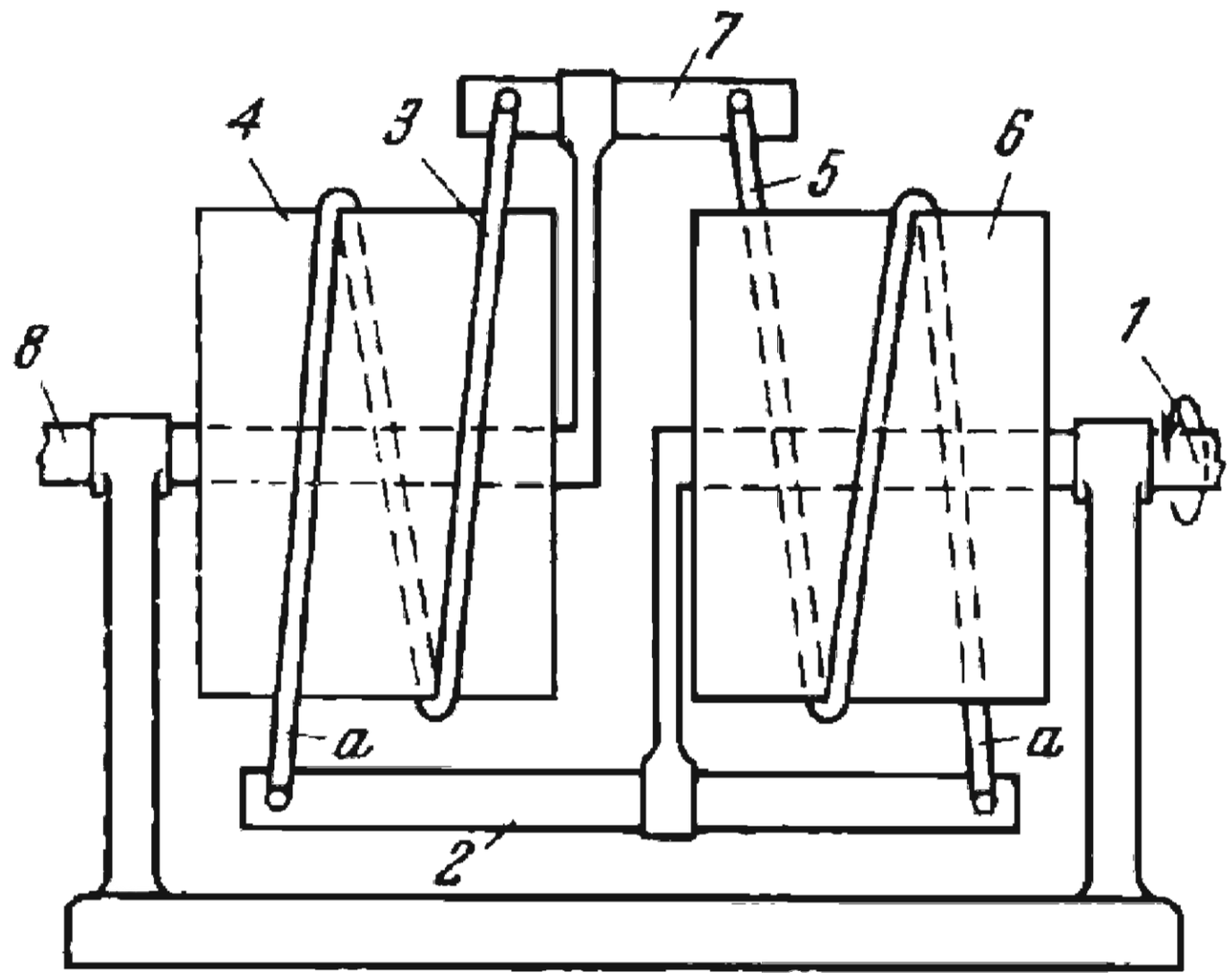
Flexible link *2* runs over pulleys *1*, *5* and *6* of equal diameter. Link *3* is connected by turning pairs *C* and *B* to flexible link *2* and to link *4* which turns about fixed axis *A*. When point *C* travels along the straight portions of its path, the motions of links *3* and *4* are equivalent to those of the connecting rod and crank of an offset slider-crank mechanism. When point *C* travels along the circular portions of its path, the motions of links *3* and *4* are equivalent to those of the connecting rod and rocker arm of a four-bar linkage in which the length of the crank equals the radius of the pulleys.

1896	DOUBLE-CRANK SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK	FL ML



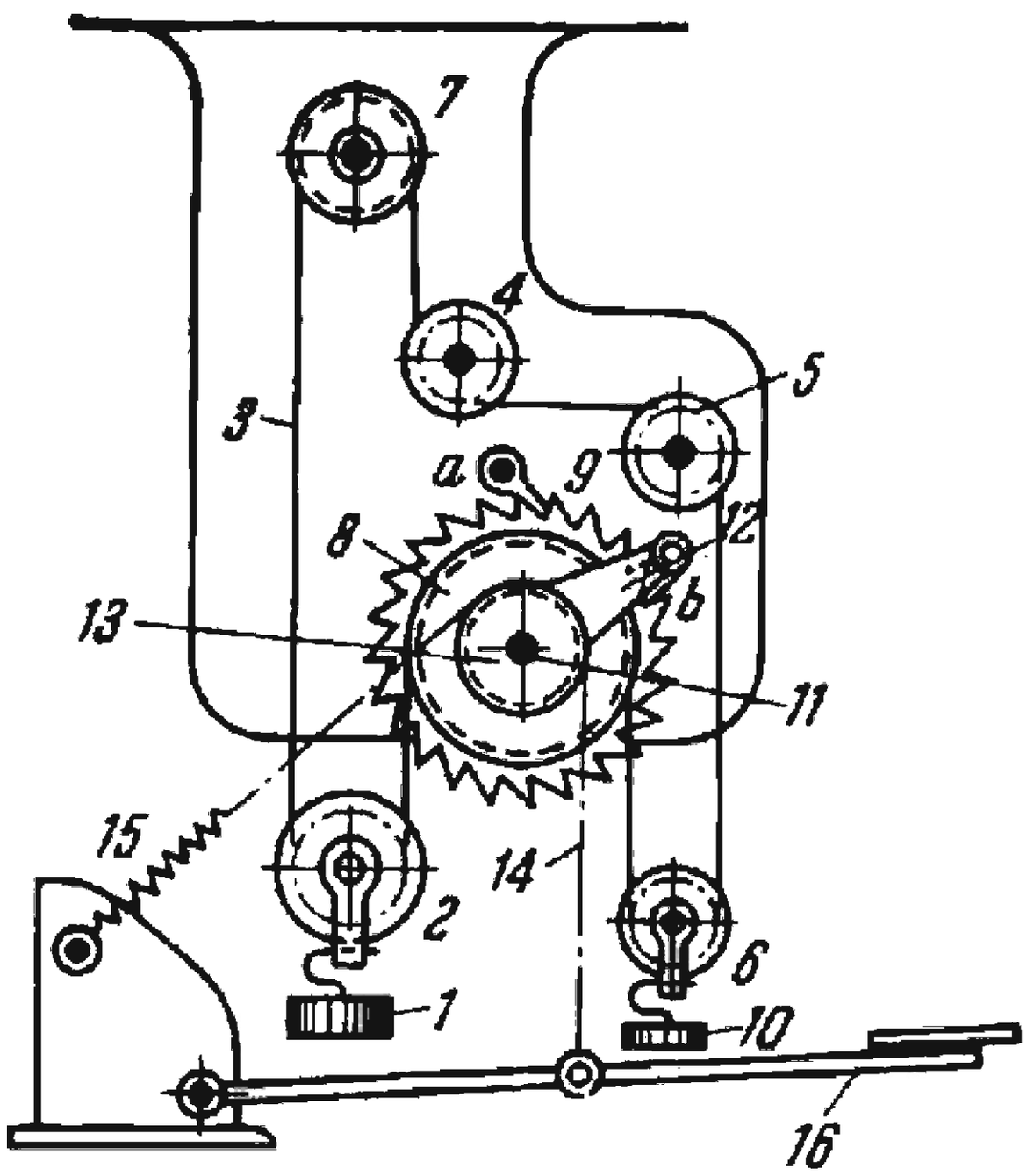
Link *3* is reciprocated by the slider-crank linkage *CDB*. Link *3* is connected by turning pairs *A* and *B* to wheels *a* which roll without slipping along plane *b*. Flexible link *d* runs over pulleys *b* which rotate freely on axes *A* and *B*. Flexible link *d* is driven by slider-crank linkage *EFG* which is connected by turning pair *G* to link *d*. When cranks *1* and *2*, connected together by meshing gears *4* and *5*, rotate about fixed axes *C* and *E*, point *e* of flexible link *d* reciprocates, participating in two motions: the motion of link *3* and the relative motion of flexible link *d* with respect to link *3*.

1897	LEVER-TYPE COUPLING WITH A FLEXIBLE-LINK TORQUE AMPLIFIER	FL ML



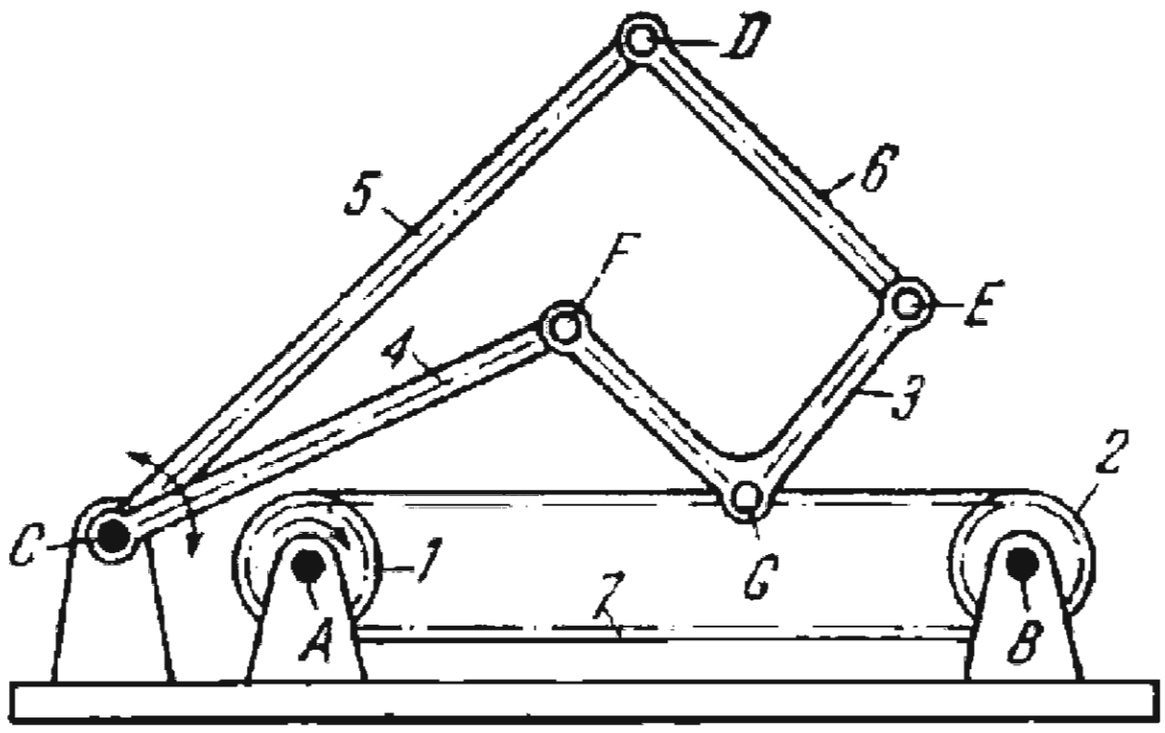
Drums *6* and *4*, mounted freely on the ends of driving shaft *1* and driven shaft *8*, are rotated in opposite directions (drum *6* clockwise and drum *4* counterclockwise when looking from the right) by a separate drive (not shown). Cross-pieces *2* and *7* are rigidly attached to the ends of shafts *1* and *8*. The cross-pieces are connected together by flexible bands *5* and *3* which are wound as shown around rotating drums *6* and *4*. If shaft *1* rotates in the direction shown by the arrow (counterclockwise when looking from the right), band *3* is coiled tight on drum *4*, and band *5* is loosened on drum *6*. The friction force developed between band *3* and drum *4* (being considerably greater than the force exerted by cross-piece *2* on band *3*) drives cross-piece *7* and shaft *8* in the same direction as shaft *1*, but with a much greater torque. If shaft *1* rotates in the opposite direction, band *5* is tightened on drum *6* and band *3* is loosened on drum *4*, so that drum *6* amplifies the torque transmitted to shaft *8*. Owing to the clearance between one of the bands and its drum, shaft *8* is reversed with a certain lag after the reversal of shaft *1*. The resulting idle rotation can be compensated by a special mechanism.

1898	LEVER-RATCHET MECHANISM WITH A FLEXIBLE-LINK DRIVE	FL ML



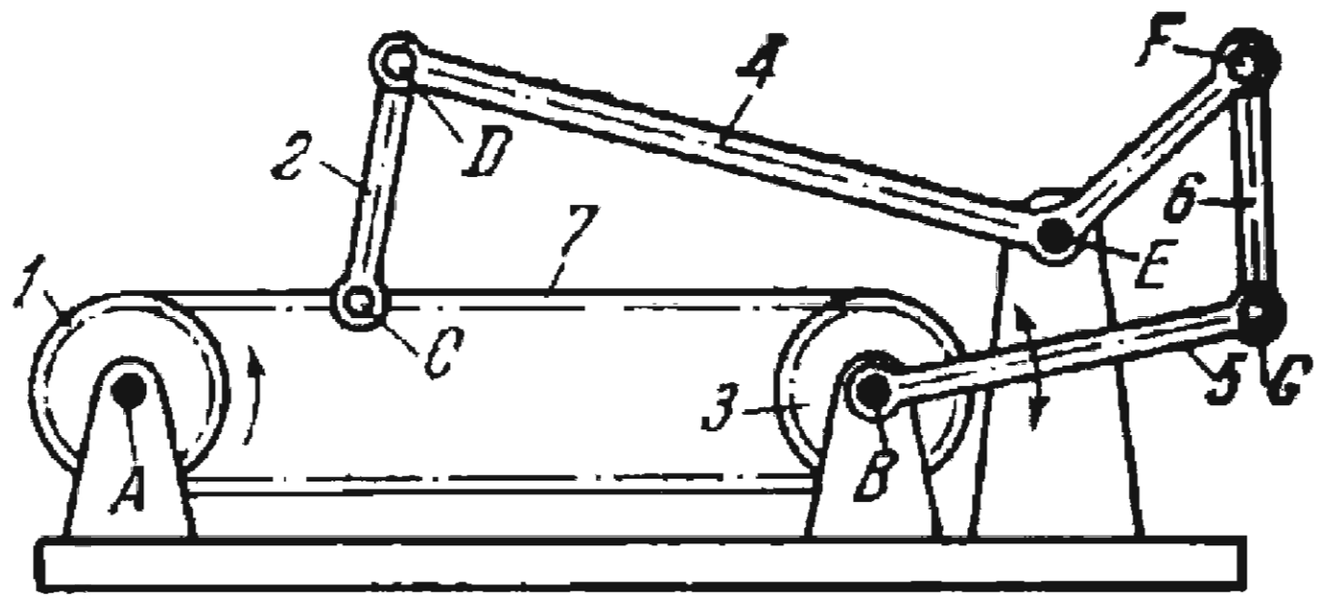
Weight *1*, moving downward by gravity, is hung from pulley *2*. Endless chain *3* runs over pulleys *2*, *4*, *5* and *6* and chain sprockets *7* and *8*. Hung from pulley *6* is weight *10* which tensions the lowered portion of chain *3* when weight *1* is raised. Chain sprocket *8* rotates about axis *11* and is rigidly attached to ratchet wheel *9*. Pawl *a* prevents counterclockwise rotation of ratchet wheel *9*. Freely mounted on axis *11* is winding lever *12* whose pawl *b* engages ratchet wheel *9*. Rigidly attached to lever *12* is chain sprocket *13* over which chain *14* runs. One end of chain *14* is attached to spring *15* and the other to pedal *16*. When weight *1* nears its lower position, pedal *16* is depressed and chain *14* turns sprocket *13*, lever *12*, pawl *b*, ratchet wheel *9* and sprocket *8* clockwise, raising weight *1*. Spring *15* returns the mechanism to the position shown. The mechanism applies a constant counterclockwise torque to the shaft on which sprocket *7* is keyed.

1899	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



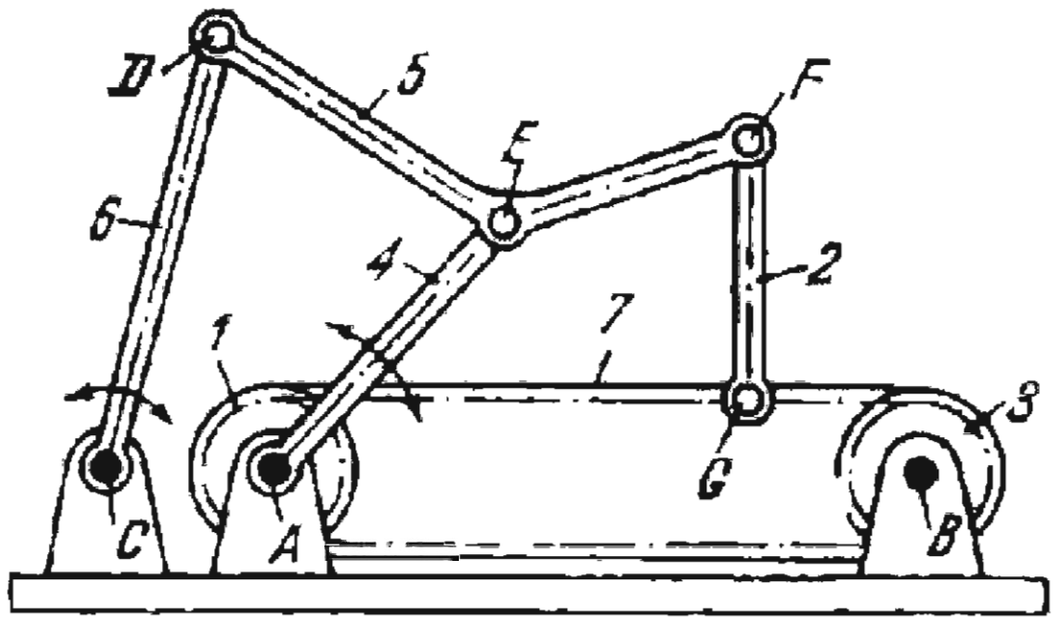
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3*, designed as a bent lever, is connected by turning pairs *G*, *F* and *E* to flexible link *7* and to links *4* and *6*. Link *4* turns about fixed axis *C*. Link *5* turns about axis *C* and is connected by turning pair *D* to link *6*. When pulley *1* rotates about axis *A*, links *3* and *6* have complex motions and links *4* and *5* oscillate about axis *C*.

1900	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



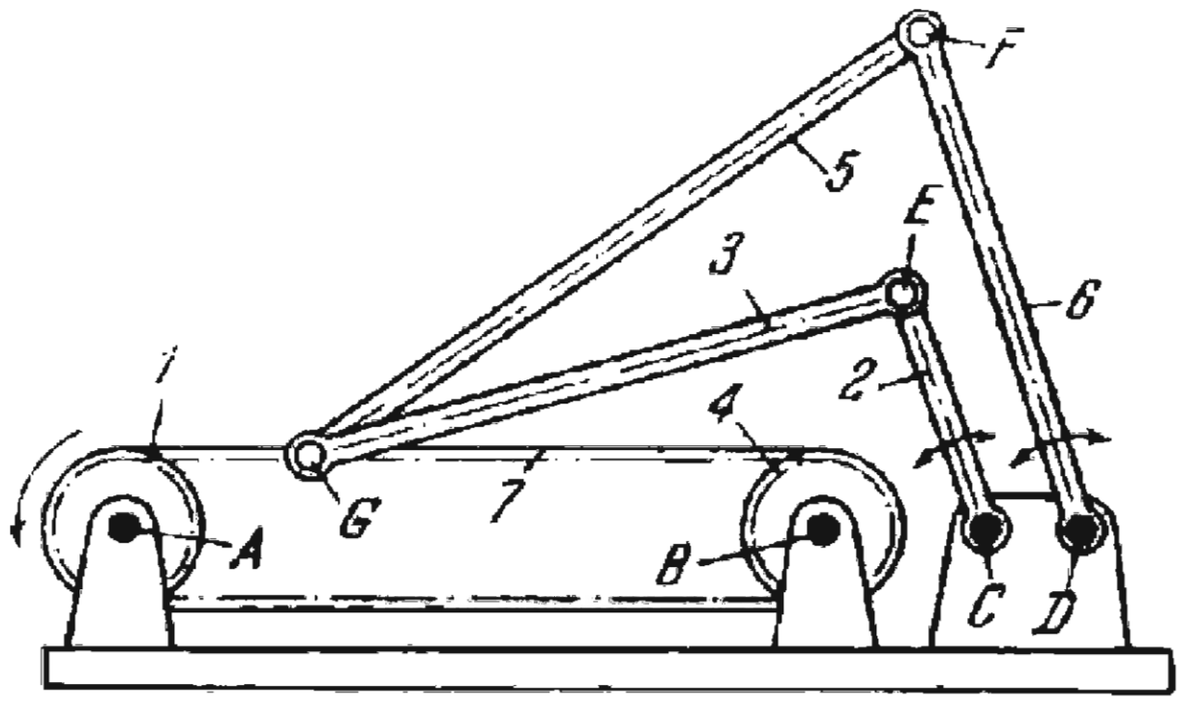
Pulleys *1* and *3* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *3* about fixed axis *B*. Link *4*, designed as a bent lever, turns about fixed axis *E* and is connected by turning pairs *D* and *F* to links *2* and *6*. Link *2* is connected by turning pair *C* to flexible link *7*. Link *5* turns about axis *B* and is connected by turning pair *G* to link *6*. When pulley *1* rotates about axis *A*, links *2* and *6* have complex motions and links *4* and *5* oscillate about axes *E* and *B*.

1901	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



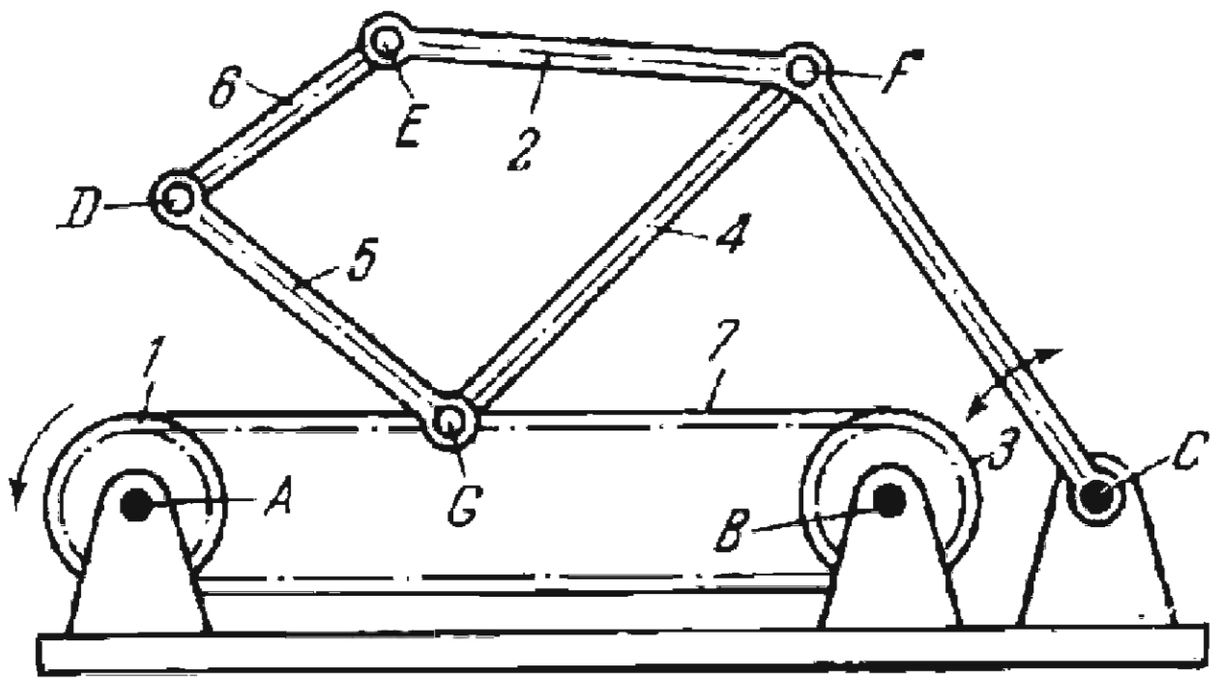
Pulleys *1* and *3* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *3* about fixed axis *B*. Link *4* turns about axis *A* and is connected by turning pair *E* to link *5*. Link *6* turns about fixed axis *C* and is connected by turning pair *D* to link *5*. Link *5*, designed as a bent lever, is connected by turning pair *F* to link *2* which, in turn, is connected by turning pair *G* to flexible link *7*. When pulley *1* rotates about axis *A*, links *2* and *5* have complex motions and links *6* and *4* oscillate about axes *C* and *A*.

1902	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



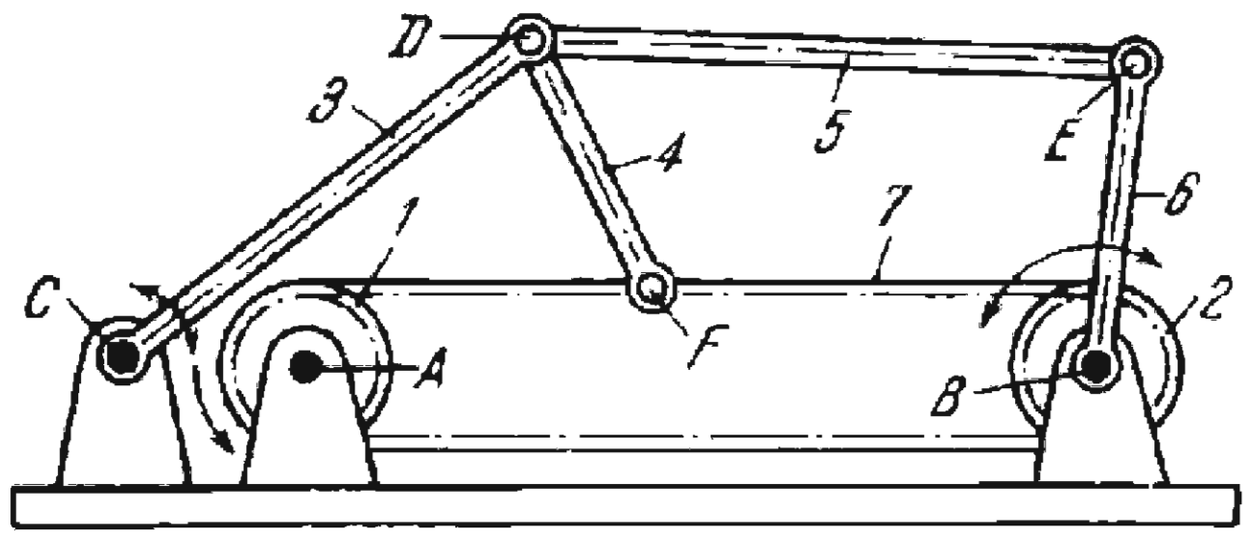
Pulleys *1* and *4* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *4* about fixed axis *B*. Links *2* and *6* turn about fixed axes *C* and *D* and are connected by turning pairs *E* and *F* to links *3* and *5* which are connected together and to flexible link *7* by turning pairs *G*. When pulley *1* rotates about axis *A*, links *3* and *5* have complex motions and links *2* and *6* oscillate about axes *C* and *D*.

1903	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



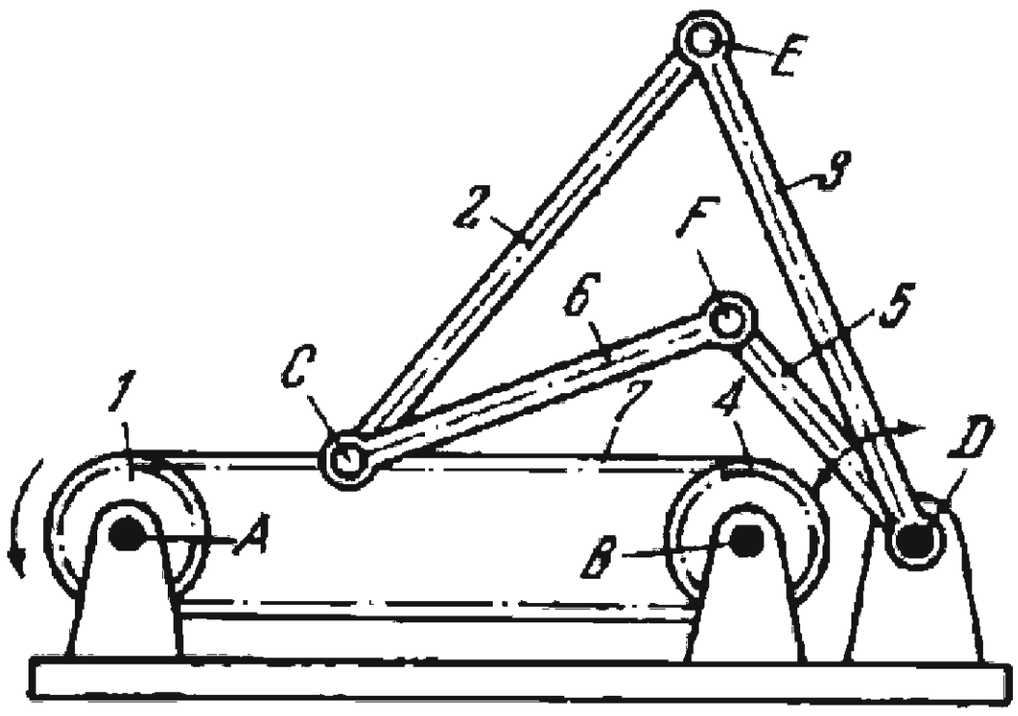
Pulleys *1* and *3* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *3* about fixed axis *B*. Link *2*, designed as a bent lever, turns about fixed axis *C* and is connected by turning pairs *E* and *F* to links *6* and *4*. Link *4* is connected by turning pairs *G* to flexible link *7* and to link *5* which, in turn, is connected by turning pair *D* to link *6*. When pulley *1* rotates about axis *A*, links *4*, *5* and *6* have complex motions and link *2* oscillates about axis *C*.

1904	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



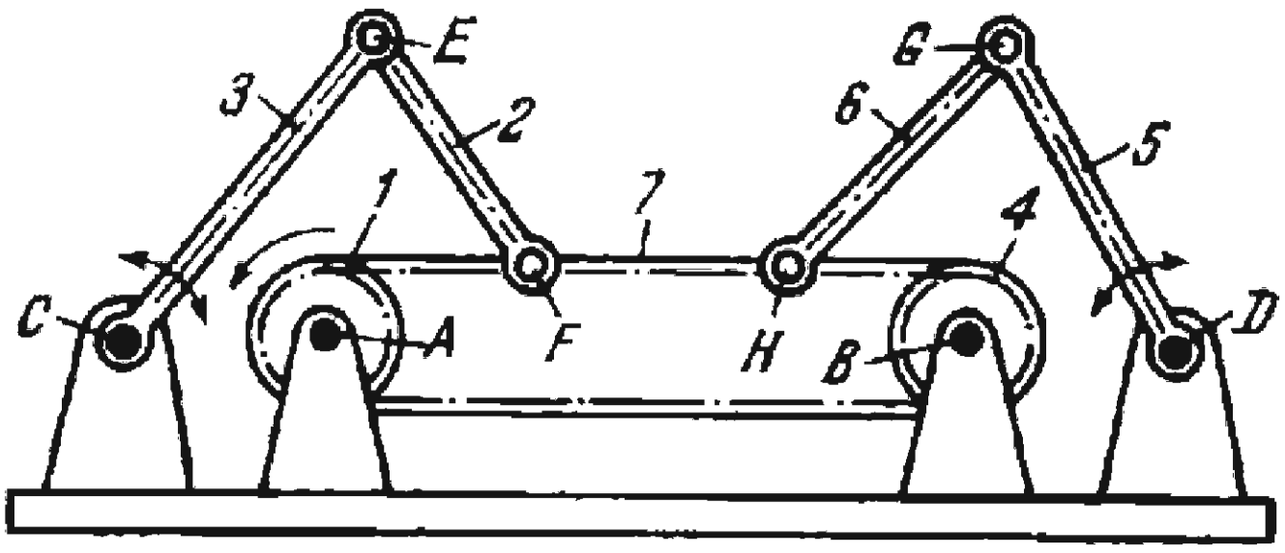
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3* turns about fixed axis *C* and is connected by turning pairs *D* to links *4* and *5*. Link *4* is connected by turning pair *F* to flexible link *7*. Link *5* is connected by turning pair *E* to link *6* which turns about axis *B*. When pulley *1* rotates about axis *A*, links *4* and *5* have complex motions and links *3* and *6* oscillate about axes *C* and *B*.

1905	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



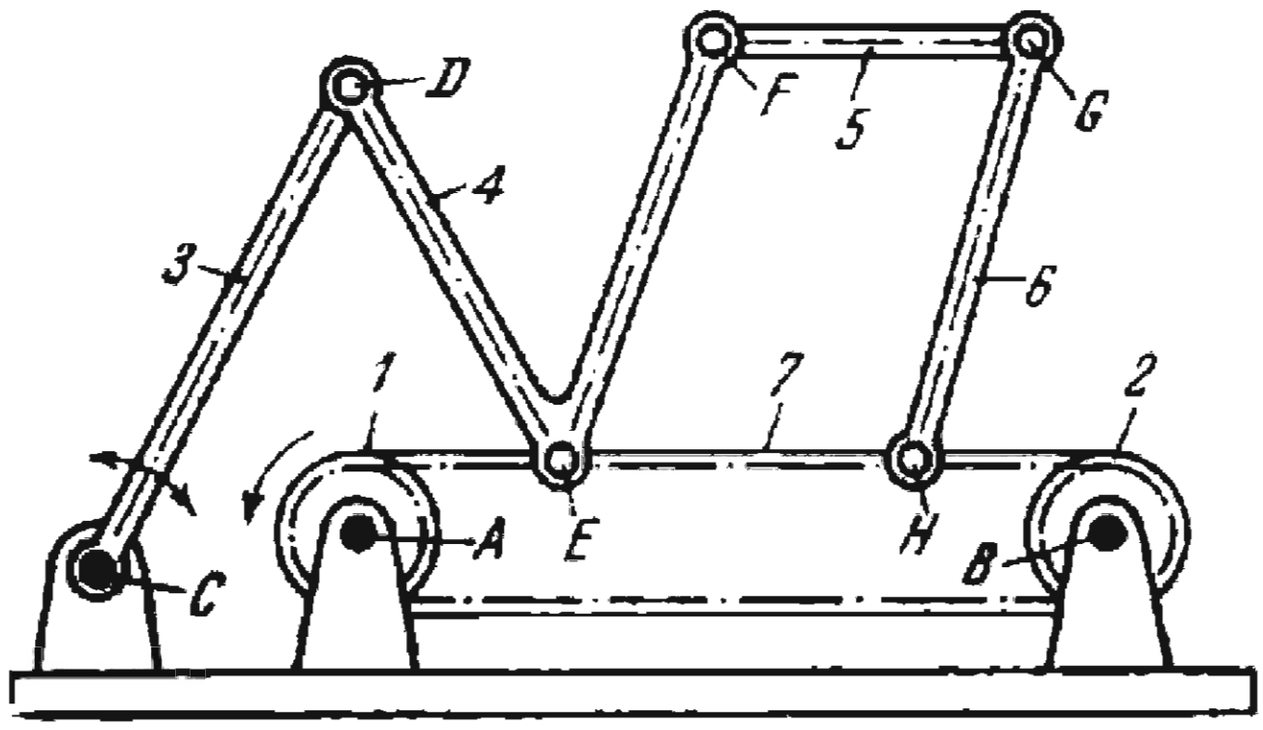
Pulleys *1* and *4* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *4* about fixed axis *B*. Links *3* and *5* turn about fixed axis *D* and are connected by turning pairs *E* and *F* to links *2* and *6* which are connected together and to flexible link *7* by turning pairs *C*. When pulley *1* rotates about axis *A*, links *2* and *6* have complex motions and links *3* and *5* oscillate about axis *D*.

1906	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



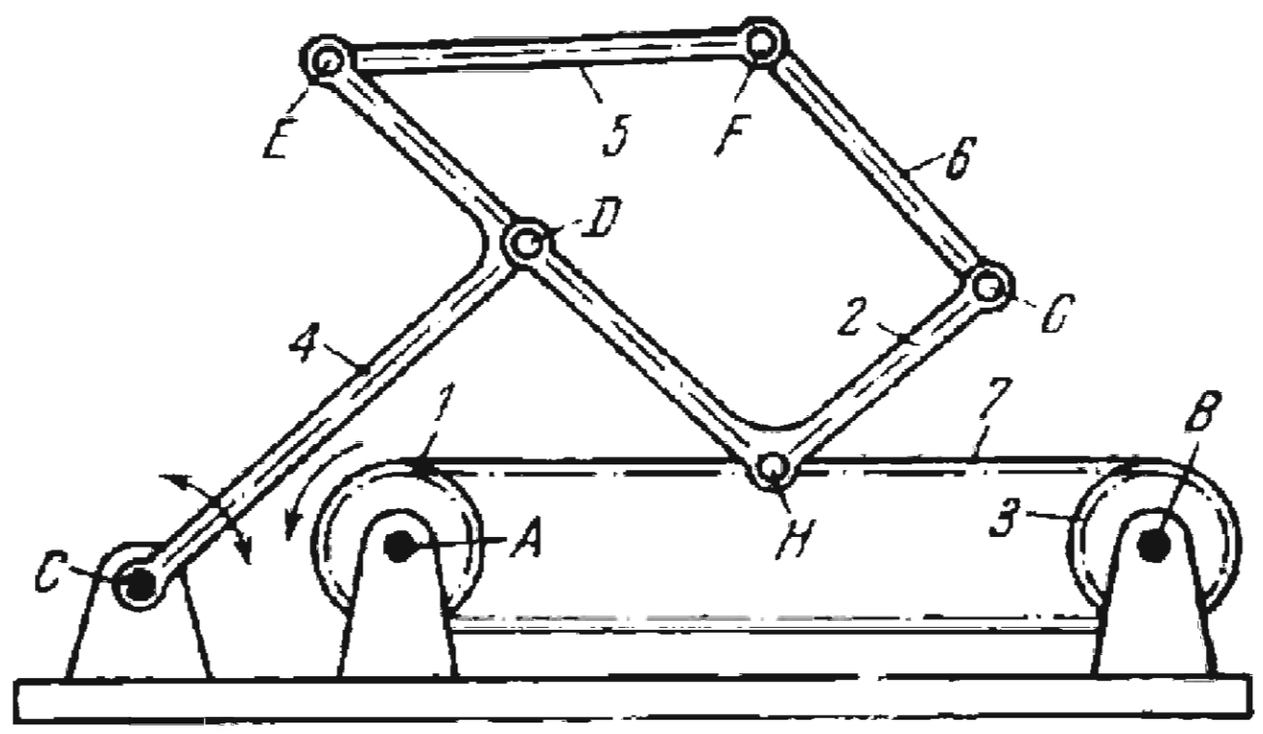
Pulleys *1* and *4* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *4* about fixed axis *B*. Links *3* and *5* turn about fixed axes *C* and *D* and are connected by turning pairs *E* and *G* to links *2* and *6* which, in turn, are connected by turning pairs *F* and *H* to flexible link *7*. When pulley *1* rotates about axis *A*, links *2* and *6* have complex motions and links *3* and *5* oscillate about axes *C* and *D*.

1907	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



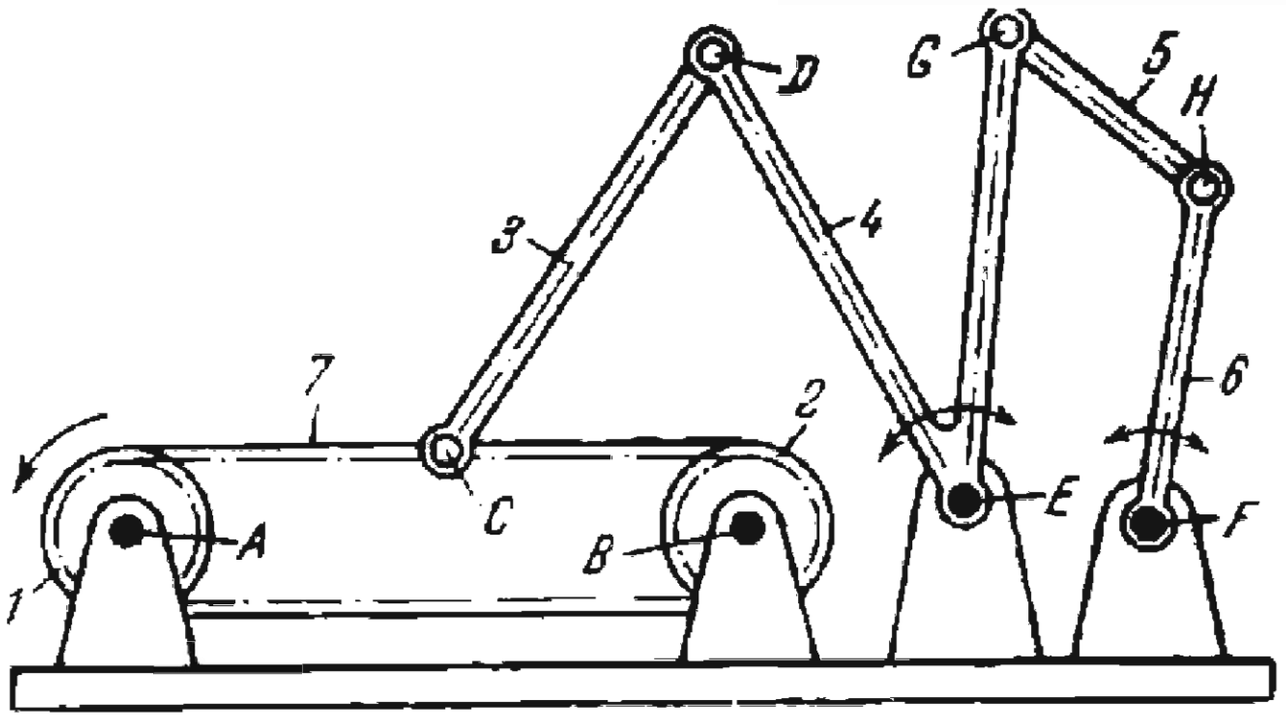
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *4*, designed as a bent lever, is connected by turning pairs *E*, *D* and *F* to flexible link *7* and to links *3* and *5*. Link *3* turns about fixed axis *C*. Link *6* is connected by turning pairs *G* and *H* to link *5* and to flexible link *7*. When pulley *1* rotates about axis *A*, links *4*, *5* and *6* have complex motions and link *3* oscillates about axis *C*.

1908	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



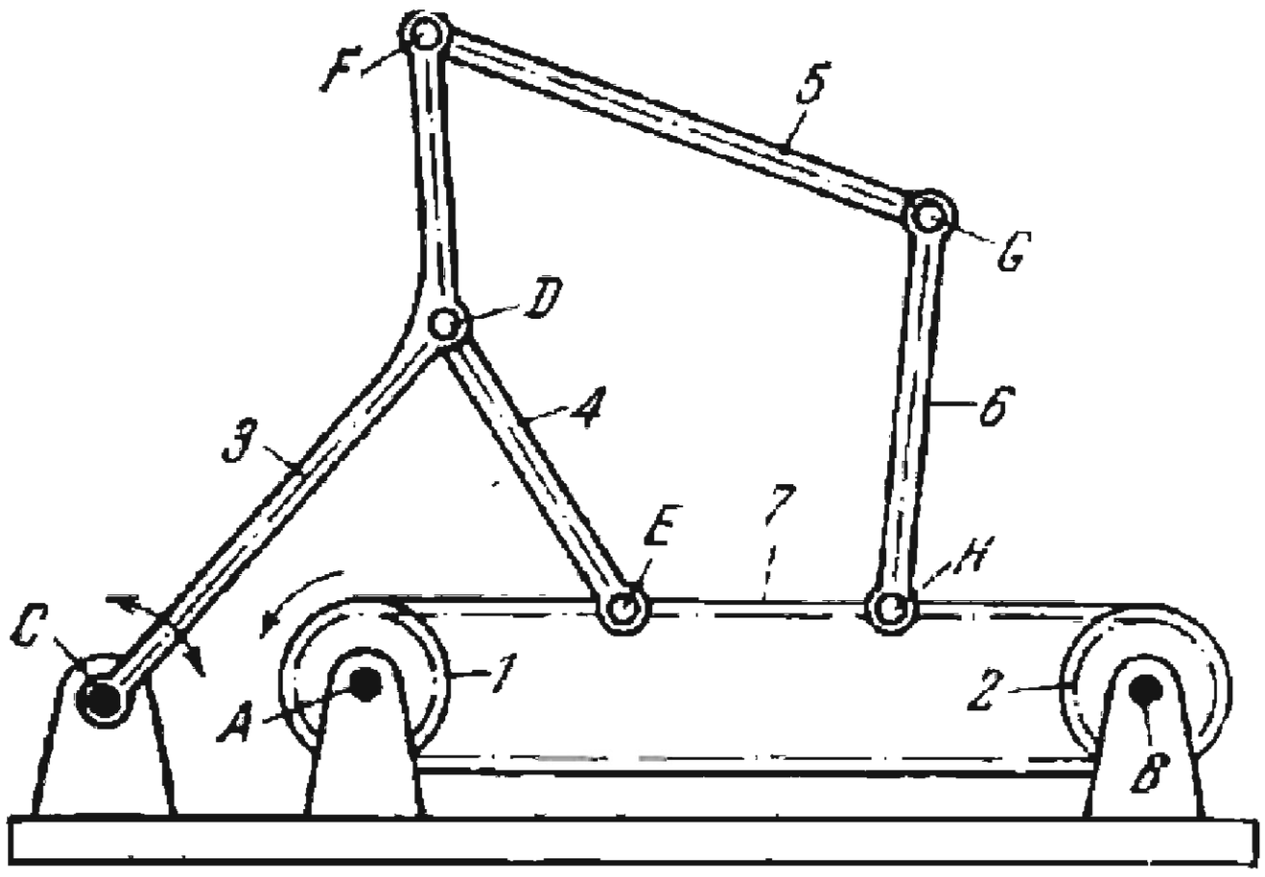
Pulleys *1* and *3* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *3* about fixed axis *B*. Link *4*, designed as a bent lever, turns about fixed axis *C* and is connected by turning pairs *D* and *E* to links *2* and *5*. Link *2*, designed as a bent lever, is connected by turning pairs *H* and *G* to flexible link *7* and to link *6* which, in turn, is connected by turning pair *F* to link *5*. When pulley *1* rotates about axis *A*, links *2*, *5* and *6* have complex motions and link *4* oscillates about axis *C*.

1909	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



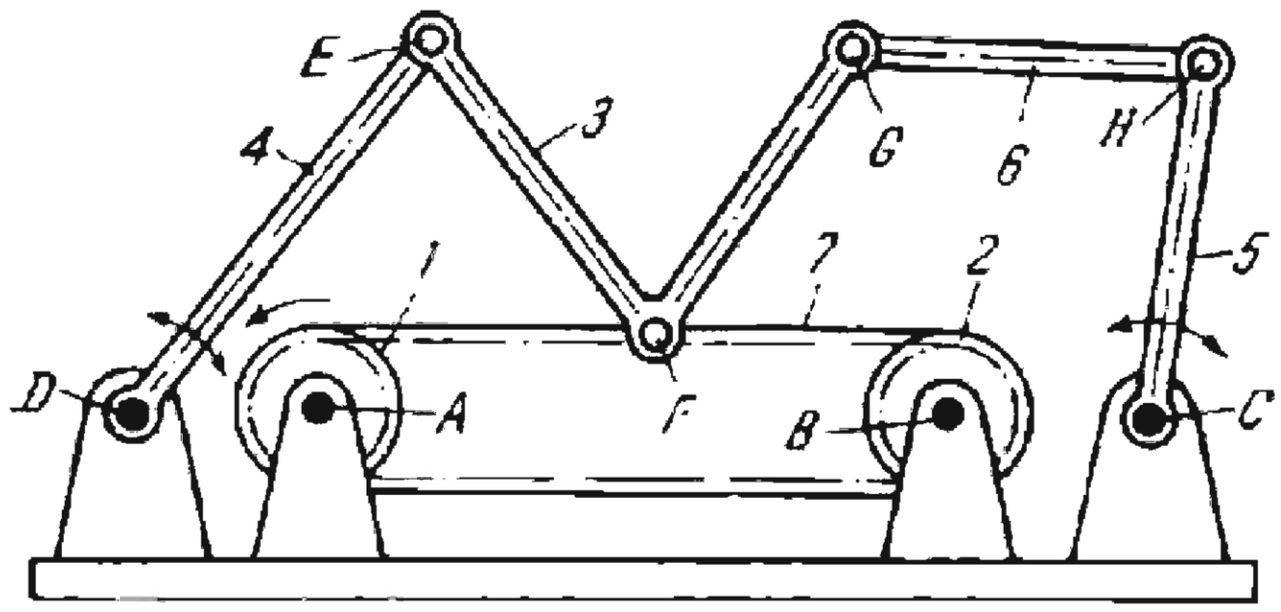
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3* is connected by turning pairs *C* and *D* to flexible link *7* and to link *4*. Link *4*, designed as a bent lever, turns about fixed axis *E* and is connected by turning pair *G* to link *5* which, in turn, is connected by turning pair *H* to link *6*. Link *6* turns about fixed axis *F*. When pulley *1* rotates about axis *A*, links *3* and *5* have complex motions and links *4* and *6* oscillate about axes *E* and *F*.

1910	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



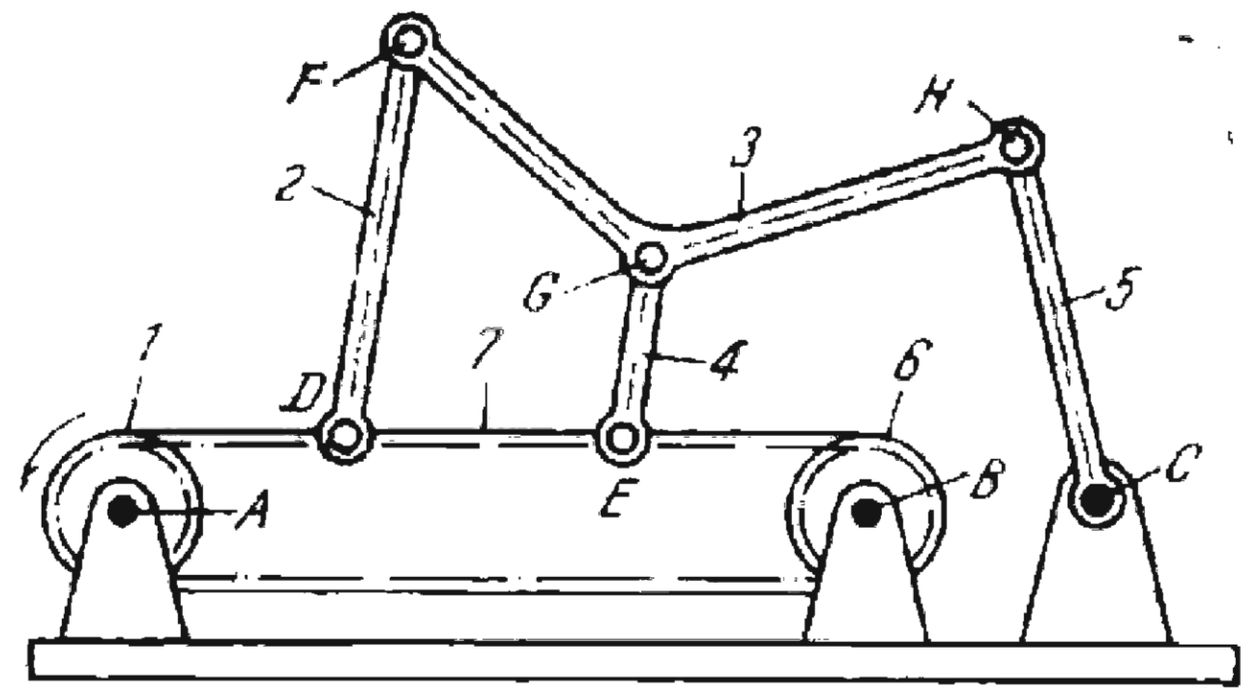
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3*, designed as a bent lever, turns about fixed axis *C* and is connected by turning pairs *F* and *D* to link *5* and to link *4* which, in turn, is connected by turning pair *E* to flexible link *7*. Link *6* is connected by turning pairs *H* and *G* to flexible link *7* and to link *5*. When pulley *1* rotates about axis *A*, links *4*, *5* and *6* have complex motions and link *3* oscillates about axis *C*.

1911	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



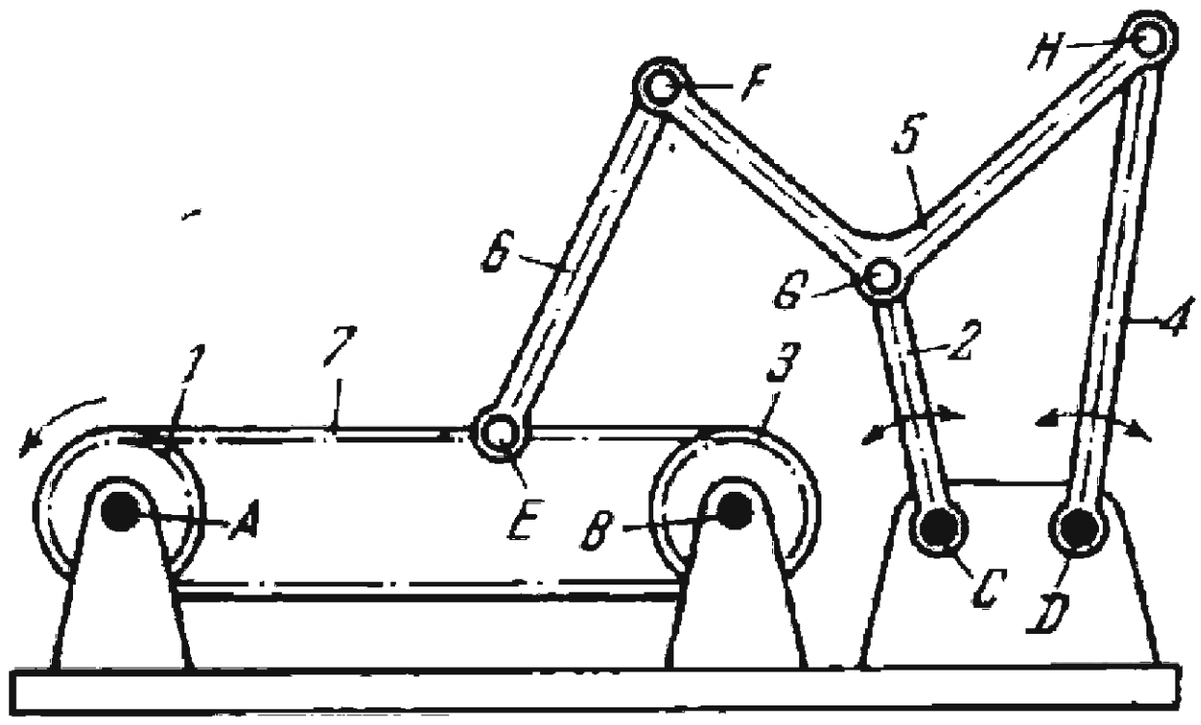
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3*, designed as a bent lever, is connected by turning pairs *E*, *F* and *G* to link *4*, flexible link *7* and link *6*. Link *4* turns about fixed axis *D*. Link *5* turns about fixed axis *C* and is connected by turning pair *H* to link *6*. When pulley *1* rotates about axis *A*, links *3* and *6* have complex motions and links *4* and *5* oscillate about axes *D* and *C*.

1912	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK ■	FL ML



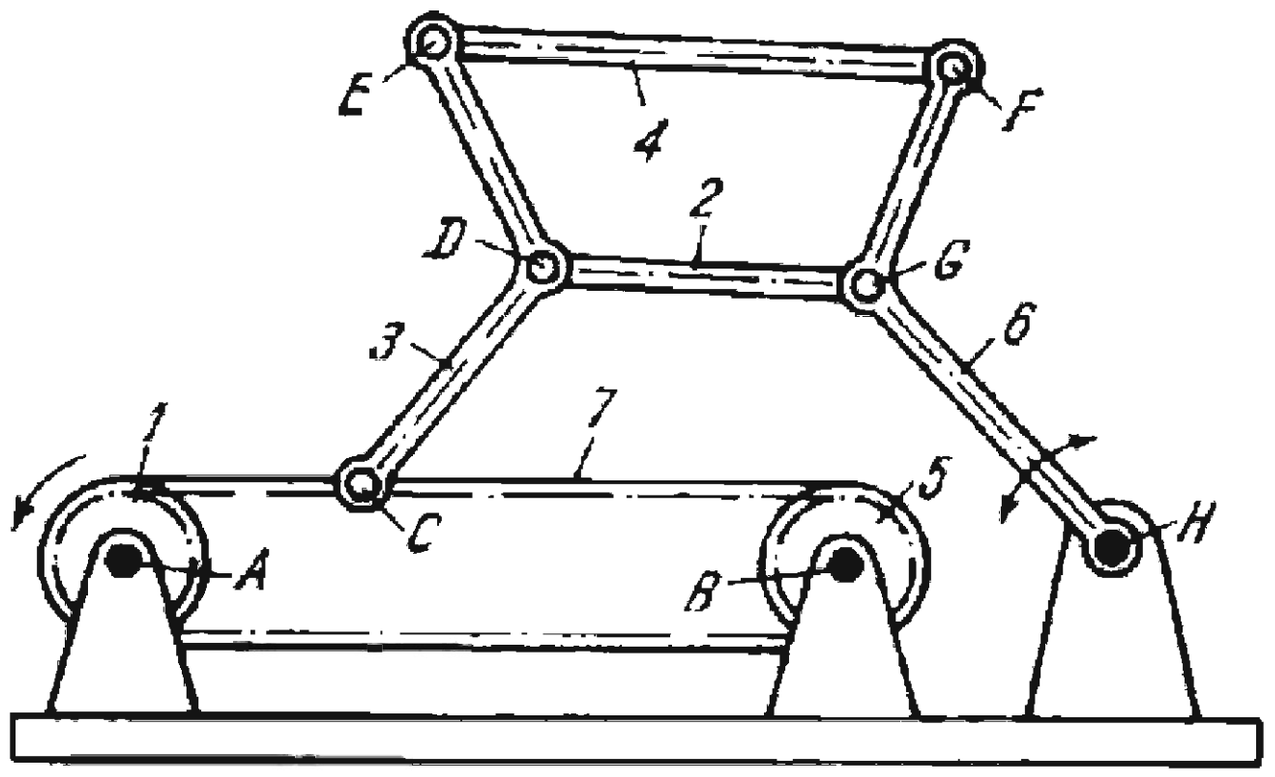
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *6* about fixed axis *B*. Link *3*, designed as a bent lever, is connected by turning pairs *F*, *G* and *H* to links *2*, *4* and *5*. Links *2* and *4* are connected by turning pairs *D* and *E* to flexible link *7*. Link *5* turns about fixed axis *C*. When pulley *1* rotates about axis *A*, links *2*, *3* and *4* have complex motions and link *5* oscillates about axis *C*.

1913	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



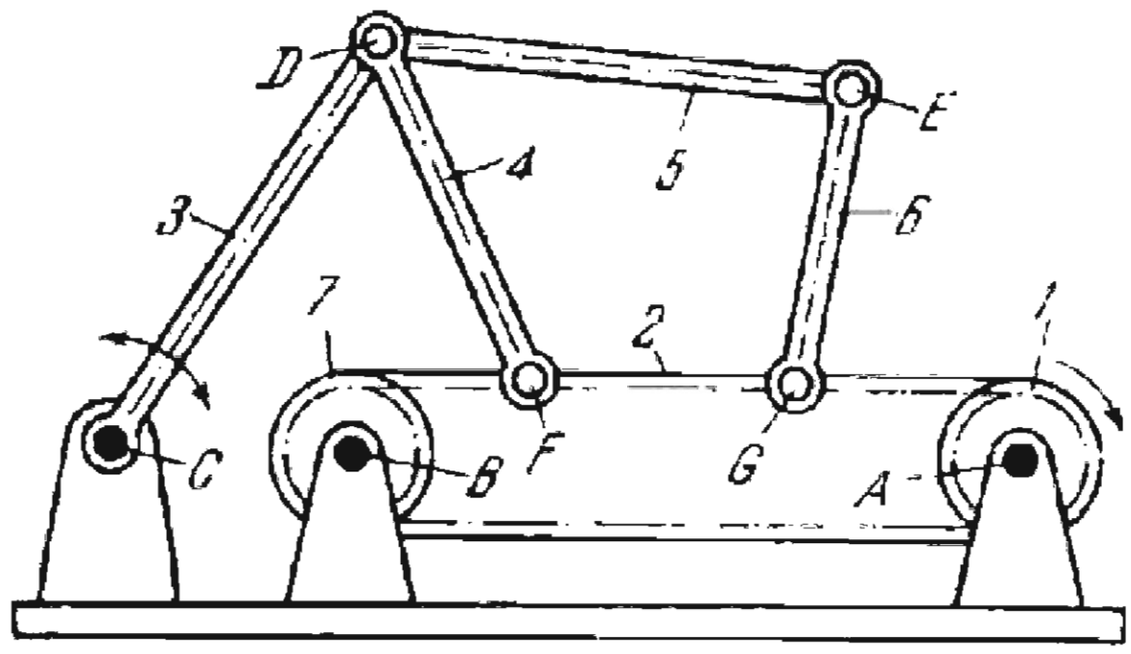
Pulleys *1* and *3* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *3* about fixed axis *B*. Link *5*, designed as a bent lever, is connected by turning pairs *G* and *H* to links *2* and *4* which turn about fixed axes *C* and *D*. Link *6* is connected by turning pairs *E* and *F* to flexible link *7* and to link *5*. When pulley *1* rotates about axis *A*, links *5* and *6* have complex motions and links *2* and *4* oscillate about axes *C* and *D*.

1914	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



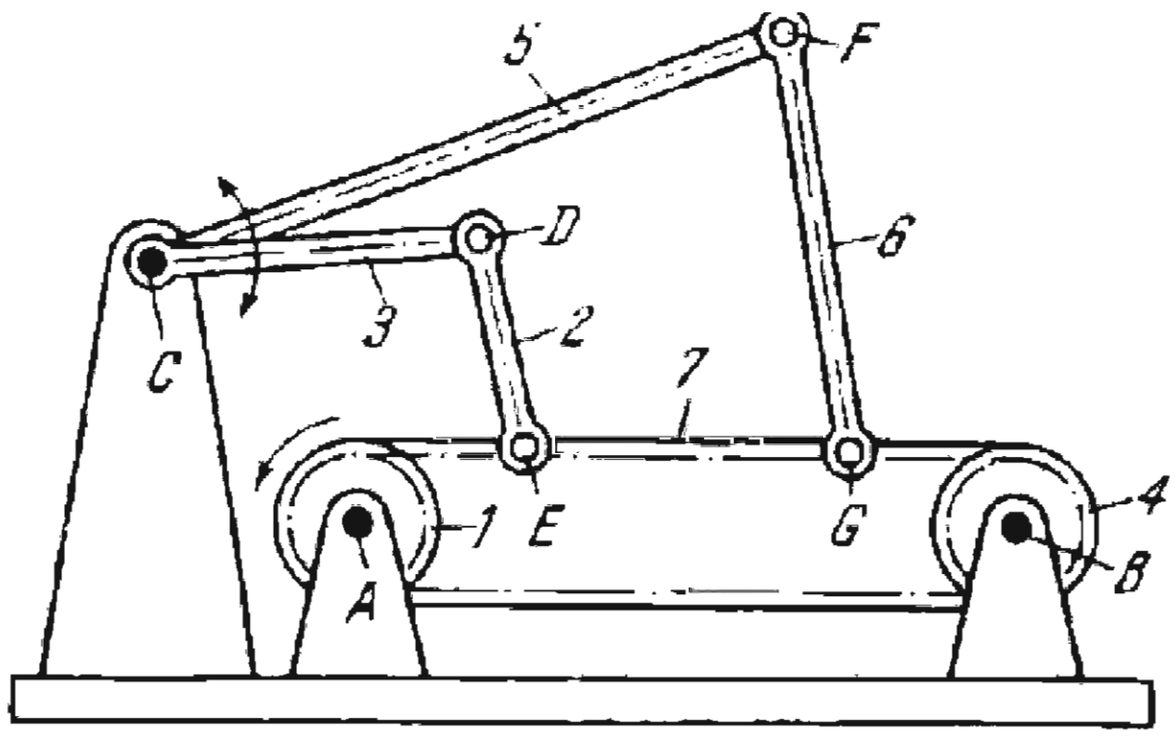
Pulleys *1* and *5* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *5* about fixed axis *B*. Link *3*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to flexible link *7* and to links *2* and *4*. Link *6* turns about fixed axis *H* and is connected by turning pairs *G* and *F* to links *2* and *4*. When pulley *1* rotates about axis *A*, links *2*, *3* and *4* have complex motions and link *6* oscillates about axis *H*.

1915	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



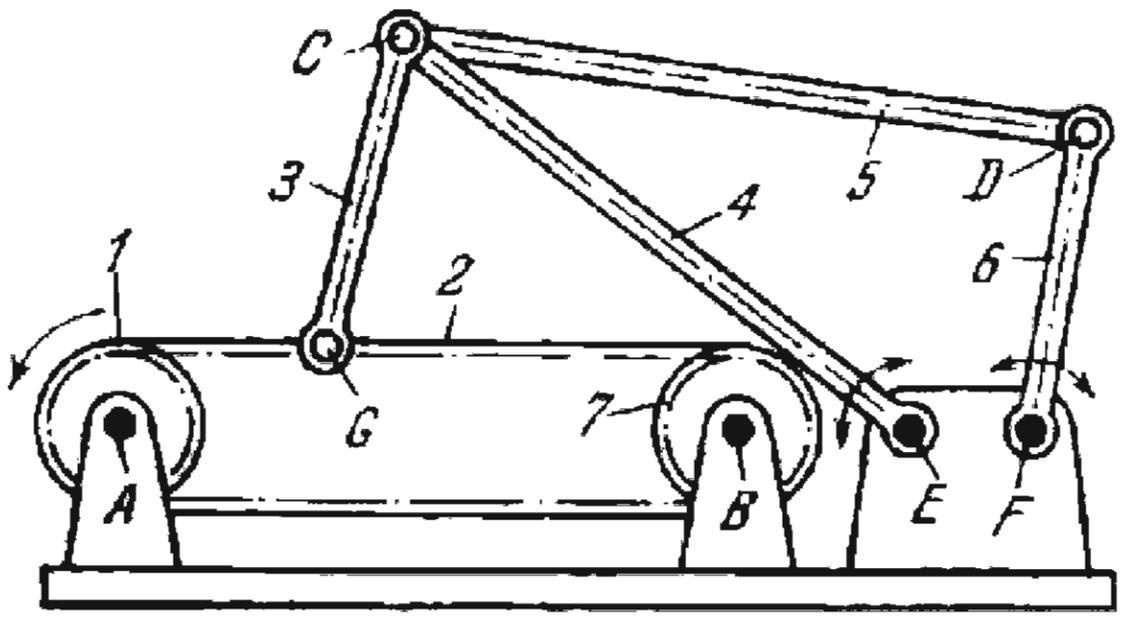
Pulleys *1* and *7* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *2*, rotates pulley *7* about fixed axis *B*. Link *3* turns about fixed axis *C* and is connected by turning pairs *D* to links *4* and *5*. Link *5* is connected by turning pair *E* to link *6*. Links *4* and *6* are connected by turning pairs *F* and *G* to flexible link *2*. When pulley *1* rotates about axis *A*, links *4*, *5* and *6* have complex motions and link *3* oscillates about axis *C*.

1916	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



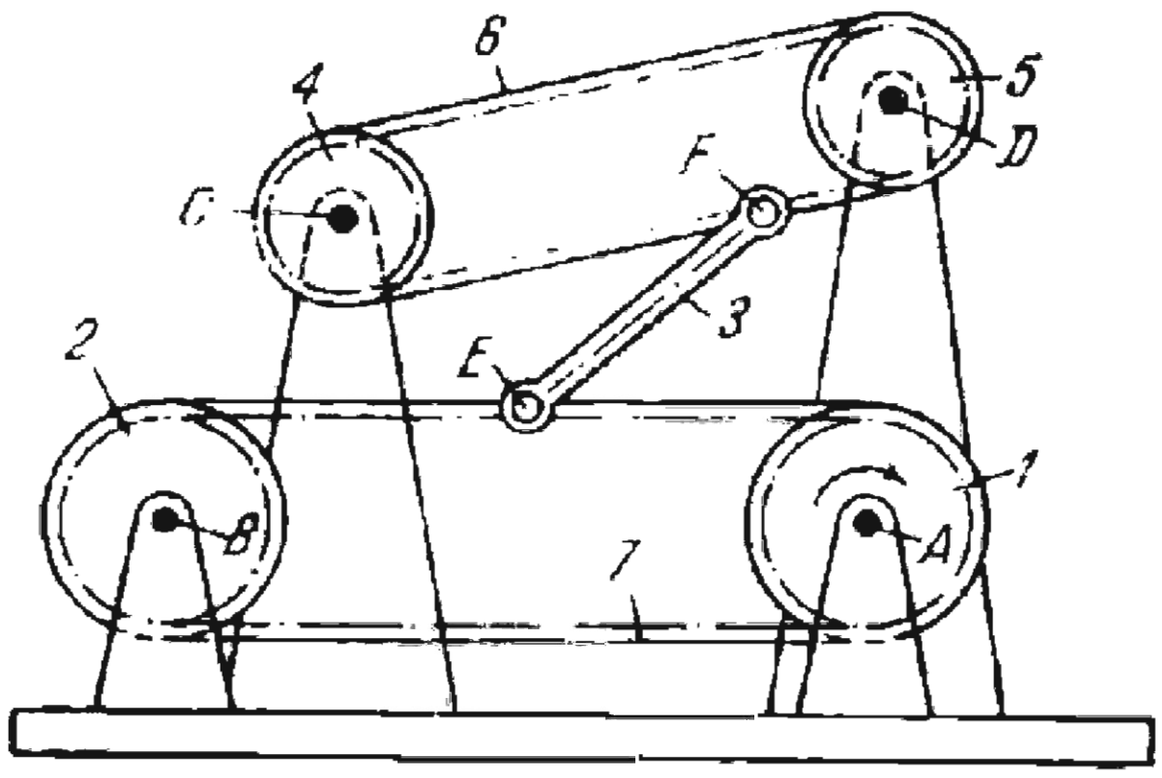
Pulleys *1* and *4* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *4* about fixed axis *B*. Links *3* and *5* turn about fixed axis *C* and are connected by turning pairs *D* and *F* to links *2* and *6* which, in turn, are connected by turning pairs *E* and *G* to flexible link *7*. When pulley *1* rotates about axis *A*, links *2* and *6* have complex motions and links *3* and *5* oscillate about axis *C*.

1917	HAIN LINKWORK MECHANISM WITH A FLEXIBLE LINK	FL ML



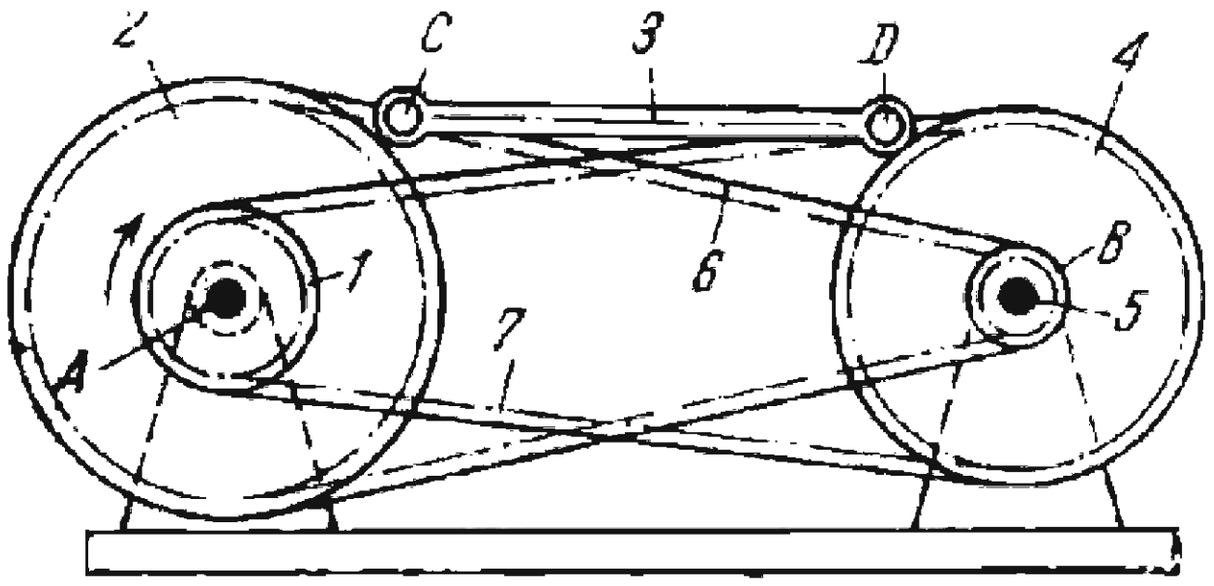
Pulleys *1* and *7* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *2*, rotates pulley *7* about fixed axis *B*. Links *4* and *6* turn about fixed axes *E* and *F* and are connected by turning pairs *C* and *D* to links *3* and *5*. Link *3* is connected by turning pair *G* to flexible link *2*. When pulley *1* rotates about axis *A*, links *3* and *5* have complex motions and links *4* and *6* oscillate about axes *E* and *F*.

1918	HAIN LEVER-TYPE MECHANISM WITH FLEXIBLE LINKS	FL ML



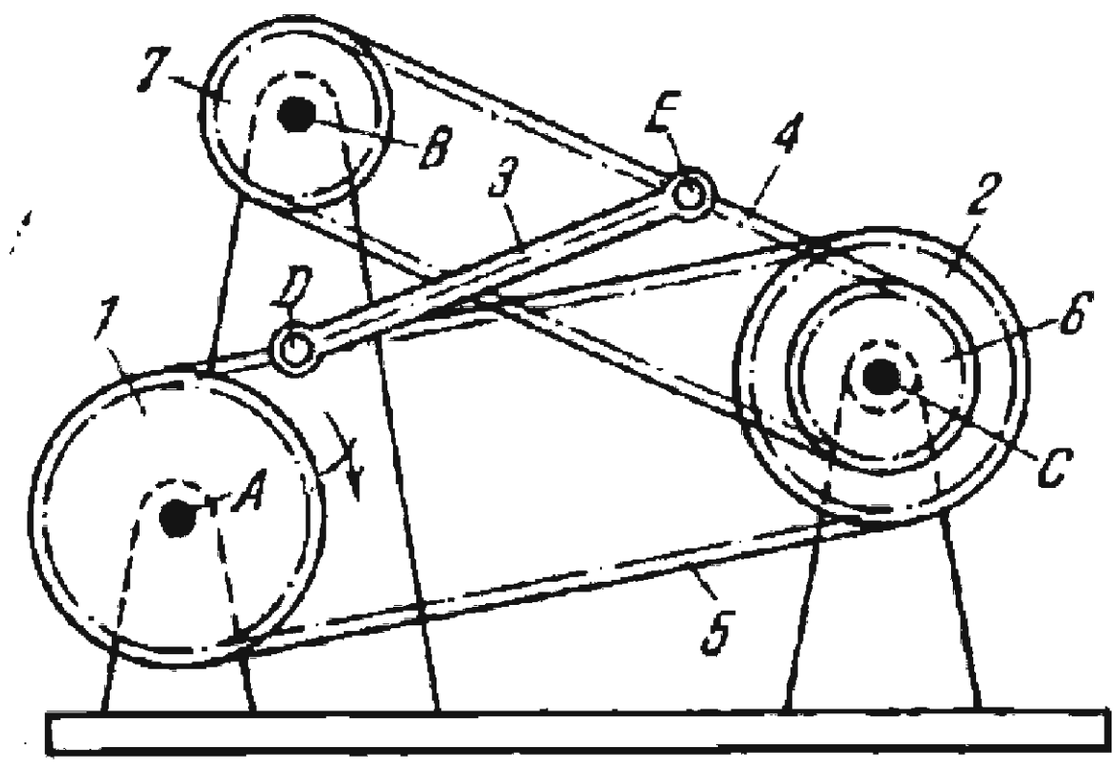
Pulleys *1* and *2* are of equal diameter, as are pulleys *4* and *5*. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3* is connected by turning pairs *E* and *F* to flexible links *7* and *6*. Flexible link *6* runs over pulleys *4* and *5* which rotate about fixed axes *C* and *D*. When pulley *1* rotates about axis *A*, pulleys *4* and *5* rotate about axes *C* and *D*, imparting complex motion to link *3*.

1919	HAIN LEVER-TYPE MECHANISM WITH FLEXIBLE LINKS	FL ML



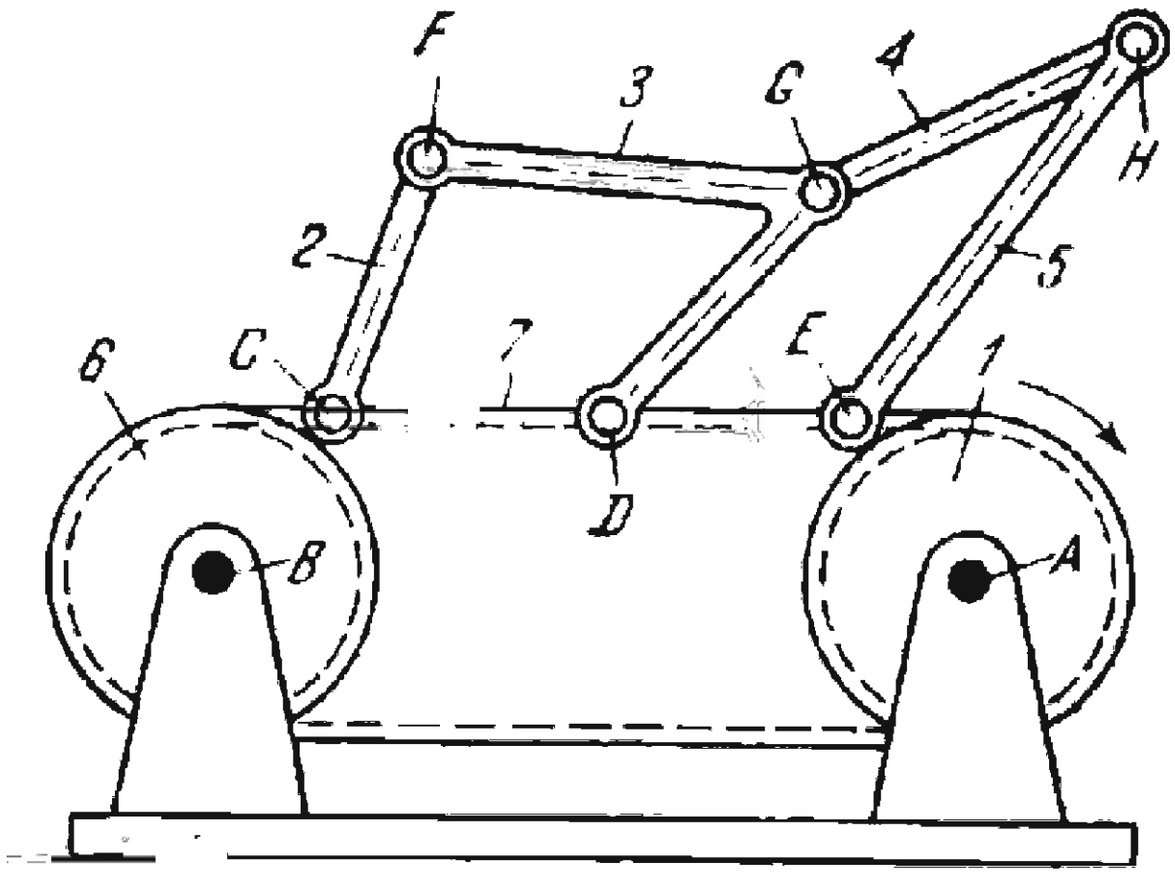
Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *4* about fixed axis *B*. Link *3* is connected by turning pairs *C* and *D* to flexible links *6* and *7*. Flexible link *6* runs over pulleys *2* and *5*. When pulley *1* rotates about axis *A*, pulleys *2* and *5* rotate about axes *A* and *B*, imparting complex motion to link *3*.

1920	HAIN LEVER-TYPE MECHANISM WITH FLEXIBLE LINKS	FL ML



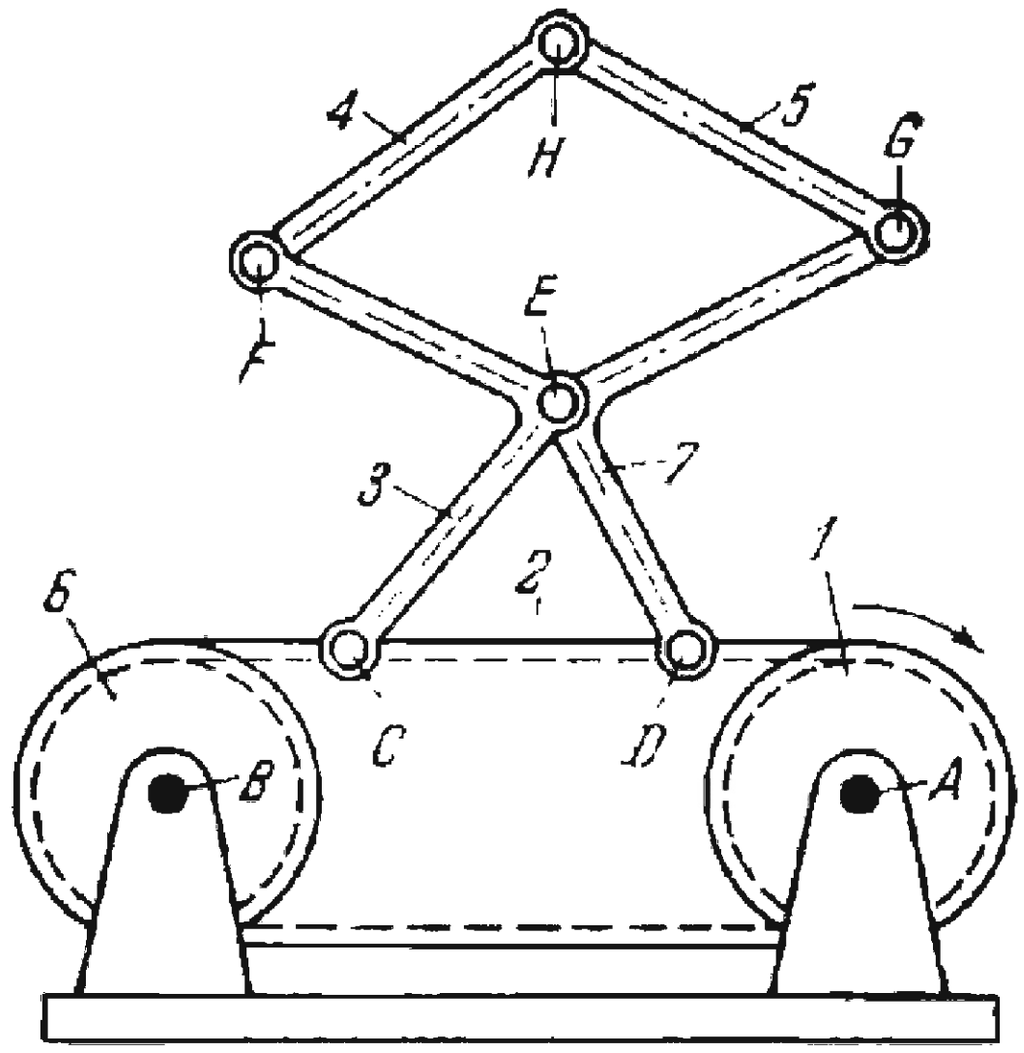
Pulleys *1* and *2* are of equal diameter, as are pulleys *7* and *6*. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* about fixed axis *C*. Link *3* is connected by turning pairs *D* and *E* to flexible links *5* and *4*. Flexible link *4* runs over pulleys *7* and *6* which rotate about fixed axes *B* and *C*. When pulley *1* rotates about axis *A*, pulleys *7* and *6* rotate about axes *B* and *C*, imparting complex motion to link *3*.

1921	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



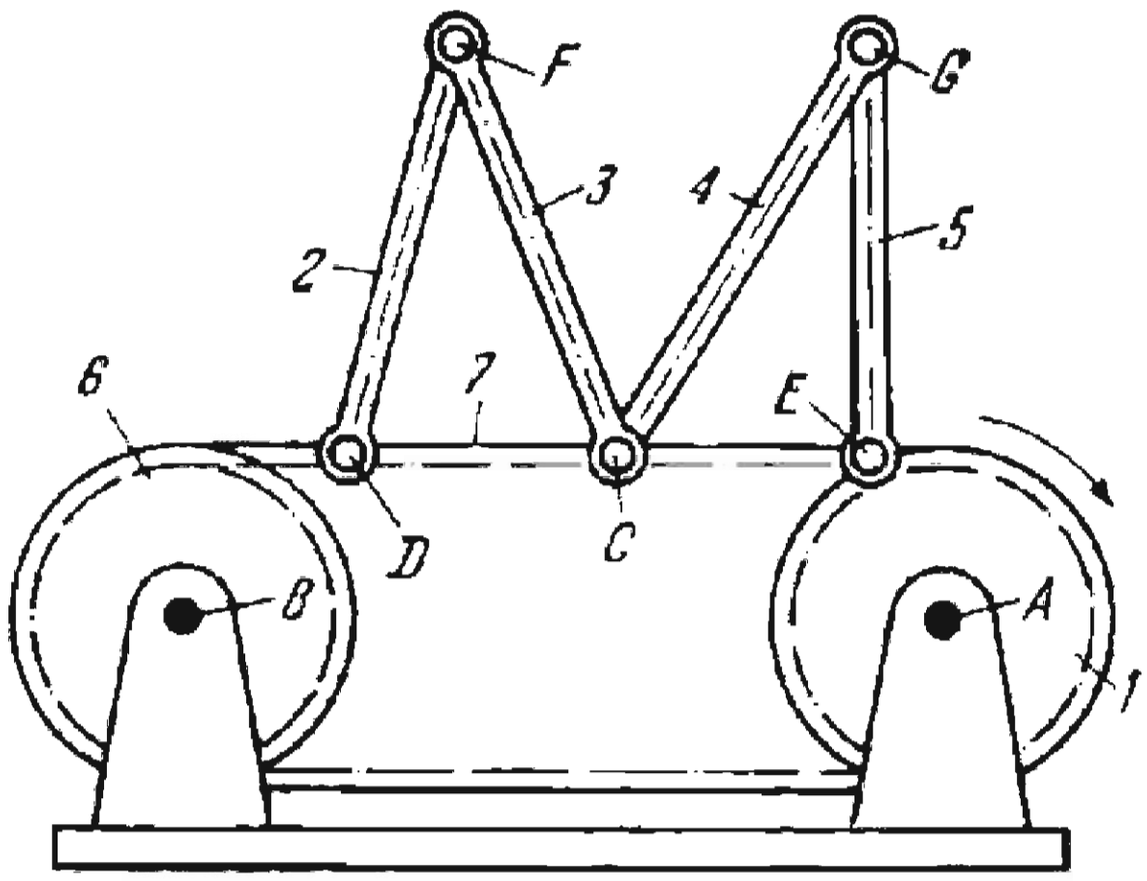
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *6* about fixed axis *B*. Links *2*, *3* and *5* are connected by turning pairs *C*, *D* and *E* to flexible link *7*. Link *4* is connected by turning pairs *G* and *H* to links *3* and *5*. Link *3* is connected by turning pair *F* to link *2*. When pulley *1* rotates about axis *A* and points *C*, *D* and *E* are all travelling along a straight portion of their path, links *2*, *3* and *5* have dwells with respect to flexible link *7*. When point *E* passes over to a circular portion of its path, links *4* and *5* turn with respect to flexible link *7*. When point *D* passes over to a circular portion of its path, links *3* and *2* turn with respect to flexible link *7*.

1922	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



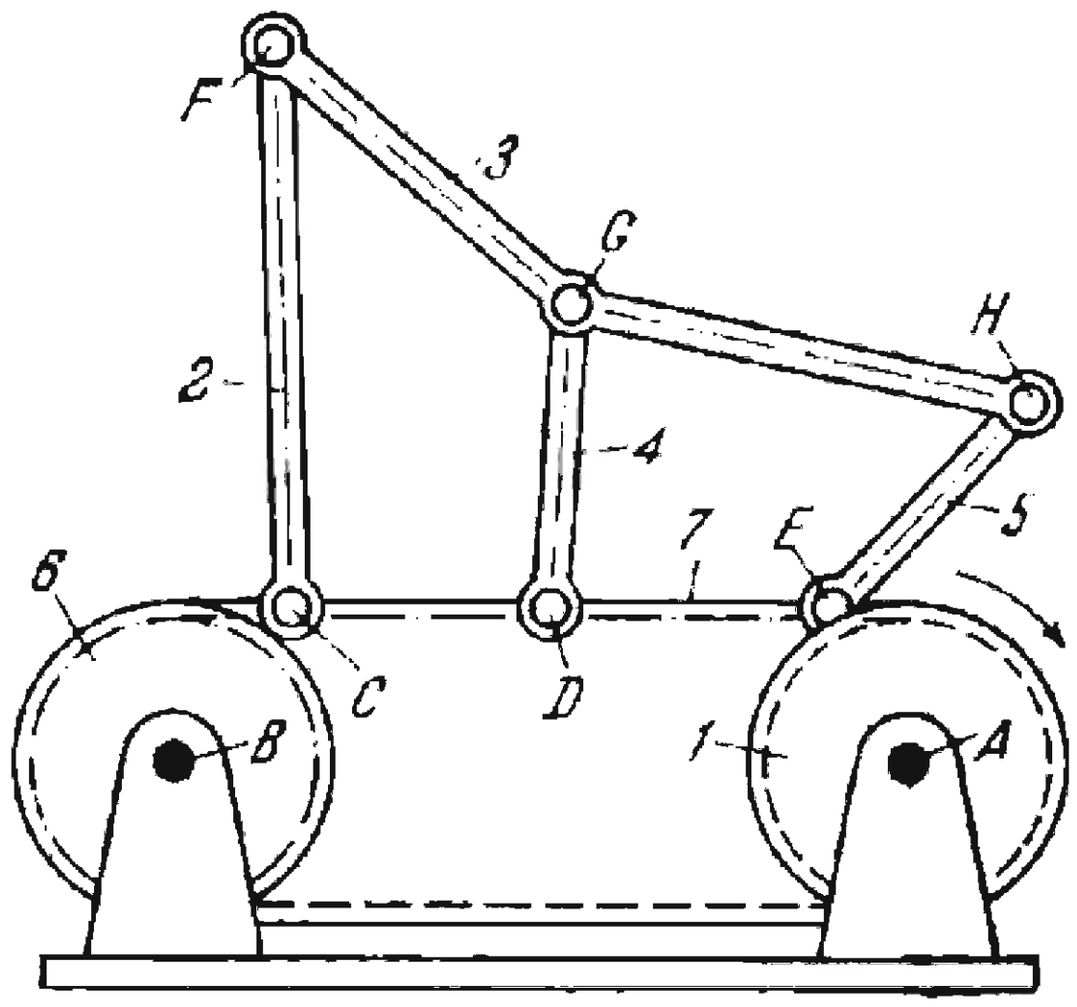
Pulleys *1* **and** *6* **are of equal diameter.** Pulley *1* rotates about **fixed axis** *A* **and, through flexible** link *2*, rotates pulley *6* about **fixed axis** *B*. **Links** *3* **and** *7* are connected together by turning **pair** *E*, **and to flexible** link *2* by turning pairs *C* and *D*. Links *4* and *5* are connected together by turning pair *H* and to links *3* and *7* by turning pairs *F* and *G*. When pulley *1* rotates about axis *A* and points *C* and *D* are travelling along a straight portion of their path, links *3*, *7*, *4* and *5* have dwells with respect to flexible link *2*. When points *C* and *D* pass over to a circular portion of their path, links *3*, *7*, *4* and *5* turn with respect to one another and with respect to flexible link *2*.

1923	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



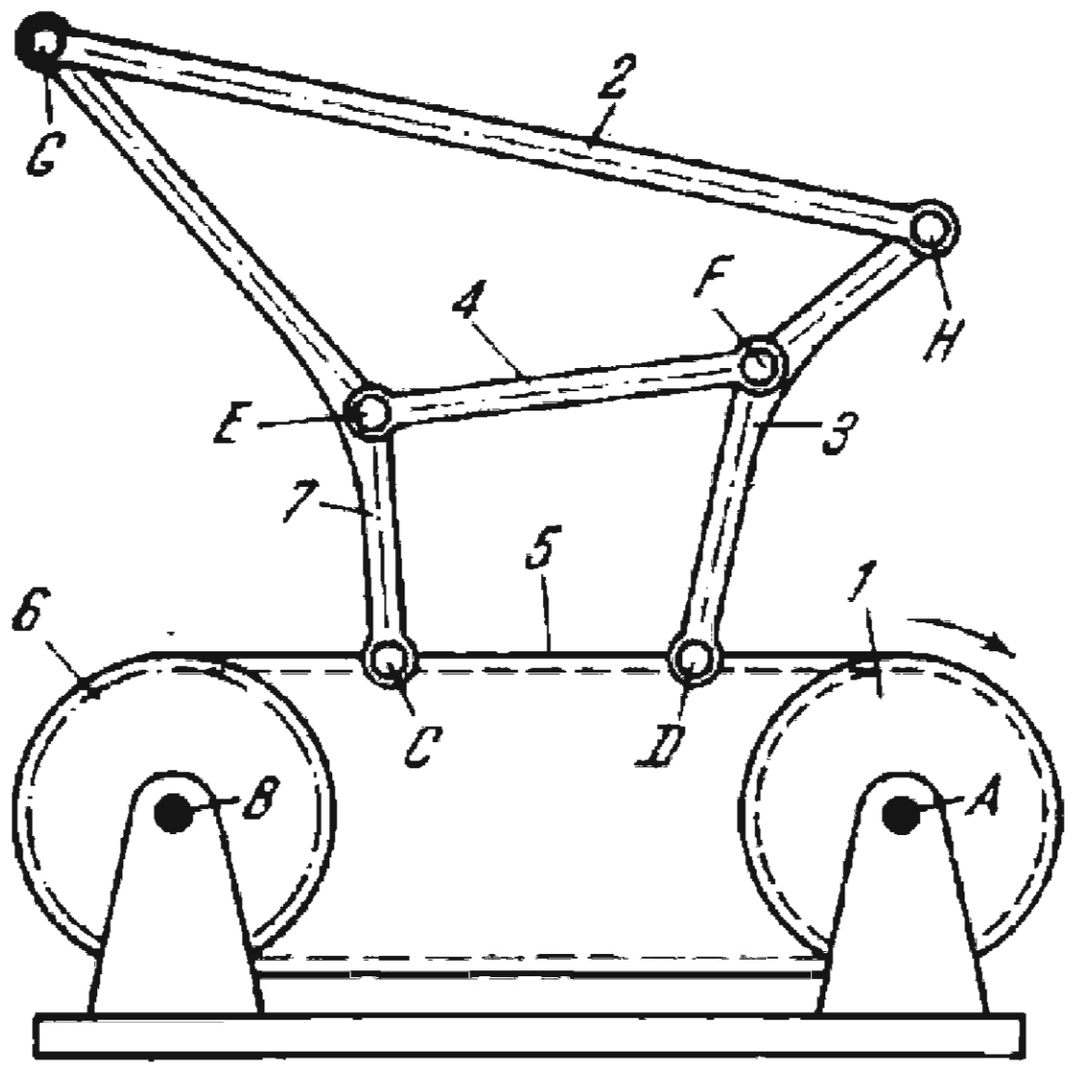
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *6* about fixed axis *B*. Links *2*, *3*, *4* and *5* are connected by turning pairs *D*, *C* and *E* to flexible link *7*. Links *2* and *3* are connected together by turning pair *F*, and links *4* and *5* by turning pair *G*. When pulley *1* rotates about axis *A* and points *D*, *C* and *E* are all travelling along a straight portion of their path, links *2*, *3*, *4* and *5* have dwells with respect to flexible link *7*. When point *E* passes over to a circular portion of its path, links *4* and *5* turn with respect to flexible link *7*. When point *C* passes over to a circular portion of its path, links *2* and *3* turn with respect to flexible link *7*.

1924	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



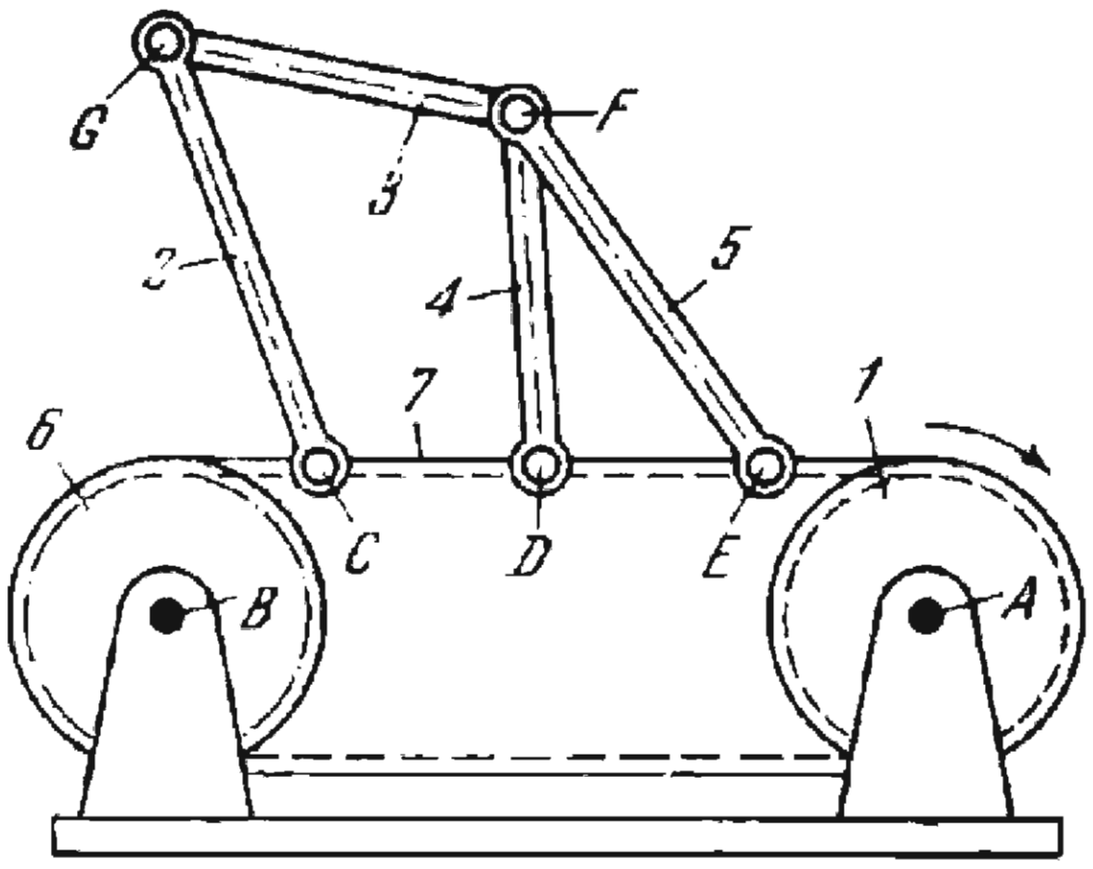
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *6* about fixed axis *B*. Link *3* is connected by turning pairs *F*, *G* and *H* to links *2*, *4* and *5* which, in turn, are connected by turning pairs *C*, *D* and *E* to flexible link *7*. When pulley *1* rotates about axis *A*, and points *C*, *D* and *E* are all travelling along a straight portion of their path, links *2*, *3*, *4* and *5* have dwells with respect to flexible link *7*. When any of the points *E*, *D* or *C* passes over to a circular portion of its path, links *2*, *3*, *4* and *5* turn with respect to flexible link *7*.

1925	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



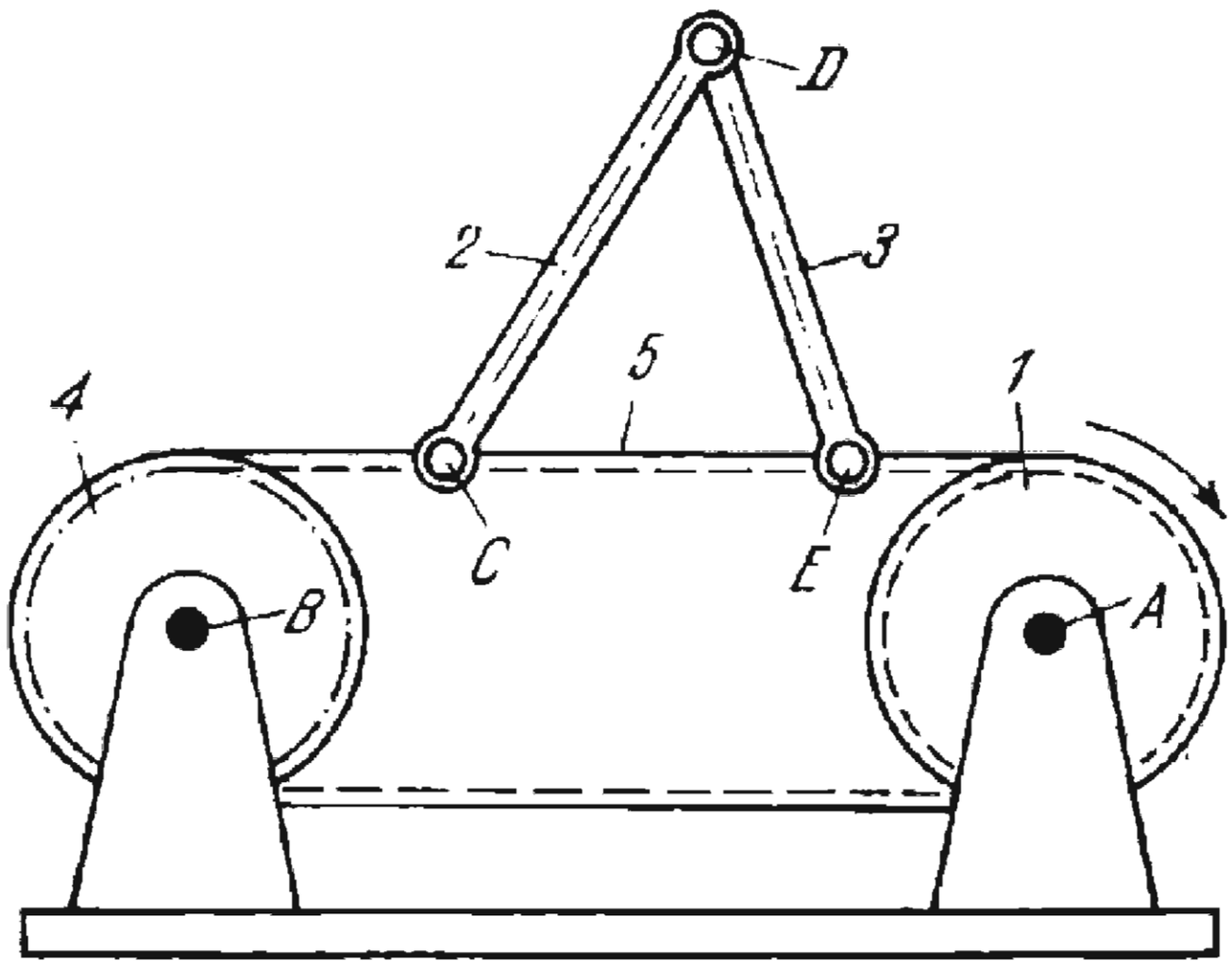
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *6* about fixed axis *B*. Links *7* and *3* are connected by turning pairs *C* and *D* to flexible link *5*, by turning pairs *E* and *F* to link *4* and by turning pairs *G* and *H* to link *2*. When pulley *1* rotates about axis *A*, and points *C* and *D* are travelling along a straight portion of their path, links *2*, *3*, *4* and *7* have dwells with respect to flexible link *5*. When either point *C* or *D* passes over to a circular portion of its path, links *2*, *3*, *4* and *7* turn with respect to flexible link *5*.

1926	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



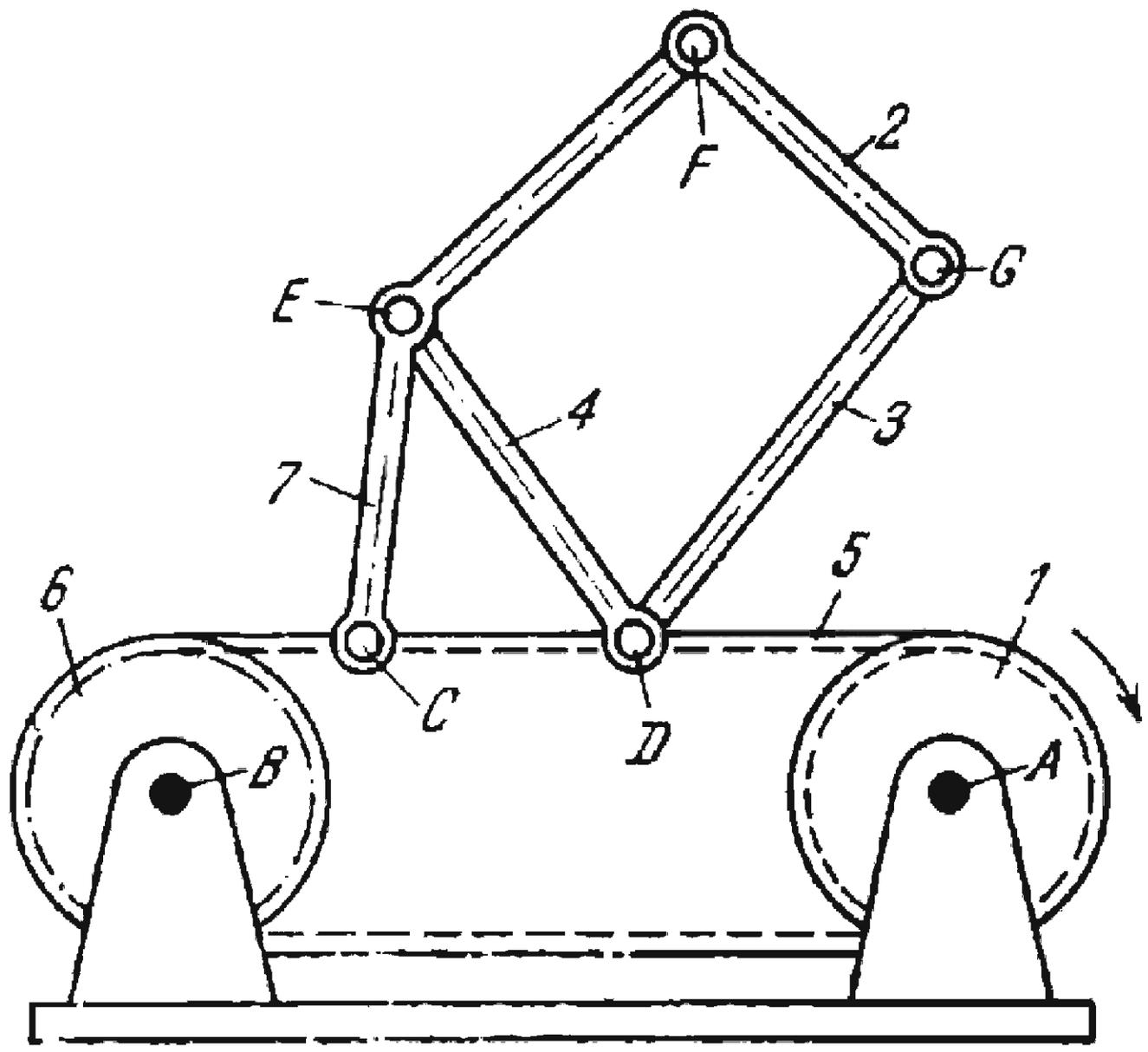
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *6* about fixed axis *B*. Links *2*, *4* and *5* are connected by turning pairs *C*, *D* and *E* to flexible link *7*. Link *3* is connected by turning pair *G* to link *2* and by turning pairs *F* to links *4* and *5*. When pulley *1* rotates about axis *A*, and points *C*, *D* and *E* are all travelling along a straight portion of their path, links *2*, *3*, *4* and *5* have dwells with respect to flexible link *7*. When any of the points *D* or *E* passes over to a circular portion of its path, links *2*, *3*, *4* and *5* turn with respect to flexible link *7*. When only point *C* passes over to a circular portion of its path, only links *2* and *3* turn with respect to link *7*.

1927	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



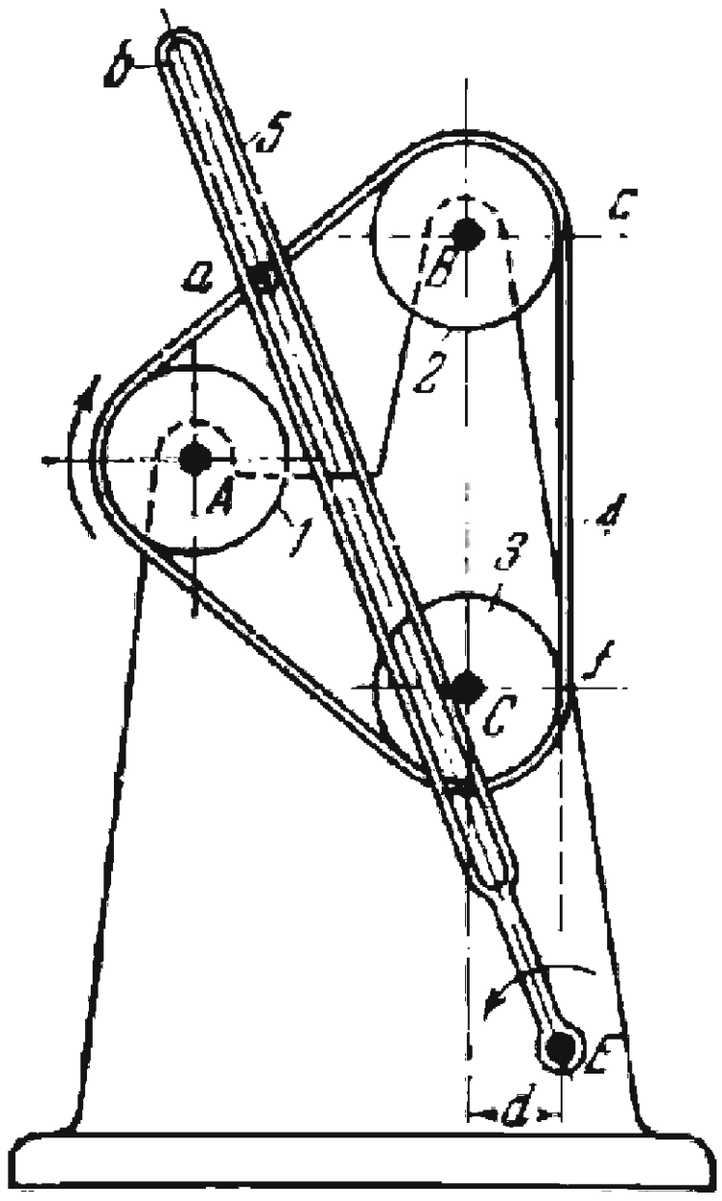
Pulleys *1* and *4* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *4* about fixed axis *B*. Links *2* and *3* are connected together by turning pair *D* and to flexible link *5* by turning pairs *C* and *E*. When pulley *1* rotates about axis *A*, and points *C* and *E* are travelling along a straight portion of their path, links *2* and *3* have dwells with respect to flexible link *5*. When either point *C* or *E* passes over to a circular portion of its path, links *2* and *3* turn with respect to flexible link *5*.

1928	HAIN LEVER-TYPE MECHANISM WITH A FLEXIBLE LINK AND PERIODIC DWELLS OF THE DRIVEN LINKS	FL D



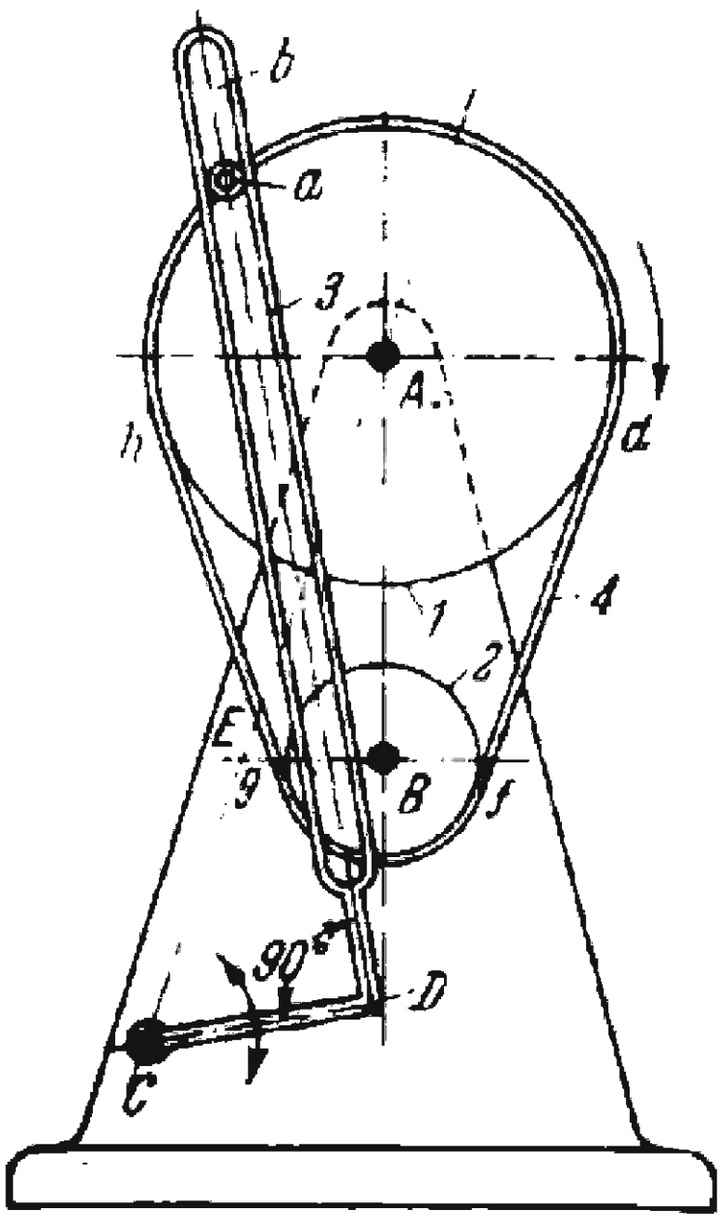
Pulleys *1* and *6* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *6* about fixed axis *B*. Links *3*, *4* and *7* are connected by turning pairs *D* and *C* to flexible link *5*. Link *7* is connected by turning pairs *E* and *F* to links *4* and *2*. Link *2* is connected by turning pair *G* to link *3*. When pulley *1* rotates about axis *A*, and points *C* and *D* are travelling along a straight portion of their path, links *2*, *3*, *4* and *7* have dwells with respect to flexible link *5*. When either point *C* or *D* passes over to a circular portion of its path, links *2*, *3*, *4* and *7* turn with respect to flexible link *5*.

1929	ARTOBOLEVSKY LINK-GEAR MECHANISM WITH A FLEXIBLE LINK AND DWELL OF THE DRIVEN LINK	FL D



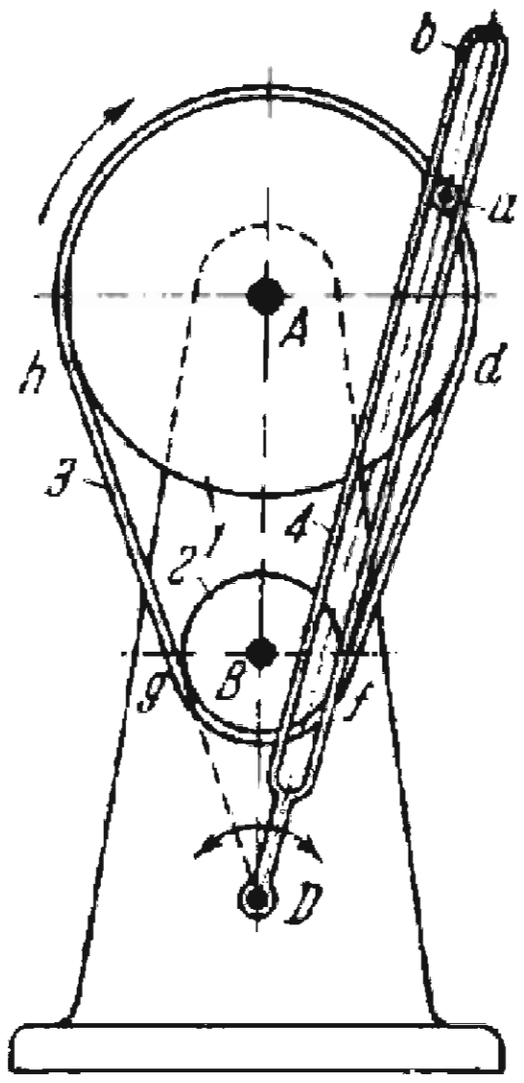
The lengths of the links comply with the conditions: $r_1 = r_2 = r_3$, where r_1, r_2 and r_3 are the radii of pulleys *1*, *2* and *3*, and the distance from point *E* to line *BC* is $d = r_1$. Pulley *1* rotates about fixed axis *A* and, through flexible link *4*, rotates pulleys *2* and *3* about fixed axes *B* and *C*. Pin *a* of flexible link *4* slides along slot *b* of slotted link *5* which turns about fixed axis *E*. When pulley *1* rotates about axis *A*, slotted link *5* oscillates about axis *E*. When pin *a* travels along vertical portion *of* of its path, slotted link *5* has a dwell in its right-hand extreme position.

1930	ARTOBOLEVSKY LINK-GEAR MECHANISM WITH A FLEXIBLE LINK AND TWO DWELLS OF THE DRIVEN LINK	FL D



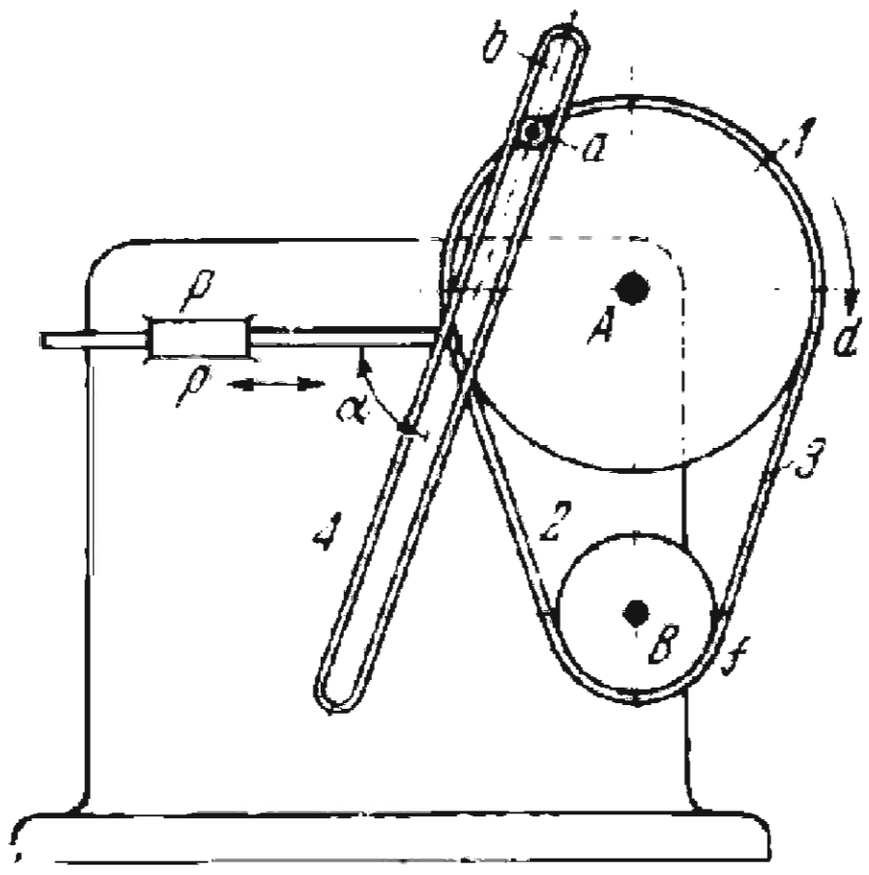
The lengths of the links comply with the conditions: $\overline{CD} = r_1$, where r_1 is the radius of pulley *1*, and the distance $\overline{BE}$ from the centre *B* of pulley *2* to line *AC* equals $r_1 - r_2$, where r_2 is the radius of pulley *2*. Pulley *1* rotates about fixed axis *A* and, through flexible link *4*, rotates pulley *2* about fixed axis *B*. Pin *a* of flexible link *4* slides along slot *b* of slotted link *3* which turns about fixed axis *C*. Slotted link *3* is designed as a bent lever with an angle of 90° at point *D*. When pulley *1* rotates about axis *A*, slotted link *3* oscillates about axis *C*. When pin *a* travels along straight portions *df* and *gh* of its path, slotted link *3* has dwells in its extreme positions.

1931	ARTOBOLEVSKY LINK-GEAR MECHANISM WITH A FLEXIBLE LINK AND TWO DWELLS OF THE DRIVEN LINK	FL D



The lengths of the links comply with the condition: $\overline{AD} : \overline{BD} = r_1 : r_2$, where r_1 and r_2 are the radii of pulleys *1* and *2*. Pulley *1* rotates about fixed axis *A* and, through flexible link *3*, rotates pulley *2* about fixed axis *B*. Pin *a* of flexible link *3* slides along slot *b* of slotted link *4* which turns about fixed axis *D*. When pulley *1* rotates about axis *A*, slotted link *4* oscillates about axis *D*. When pin *a* travels along straight portions *df* and *gh* of its path, slotted link *4* has dwells in its extreme positions.

1932	ARTOBOLEVSKY SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK AND A DWELL OF THE DRIVEN LINK	FL D

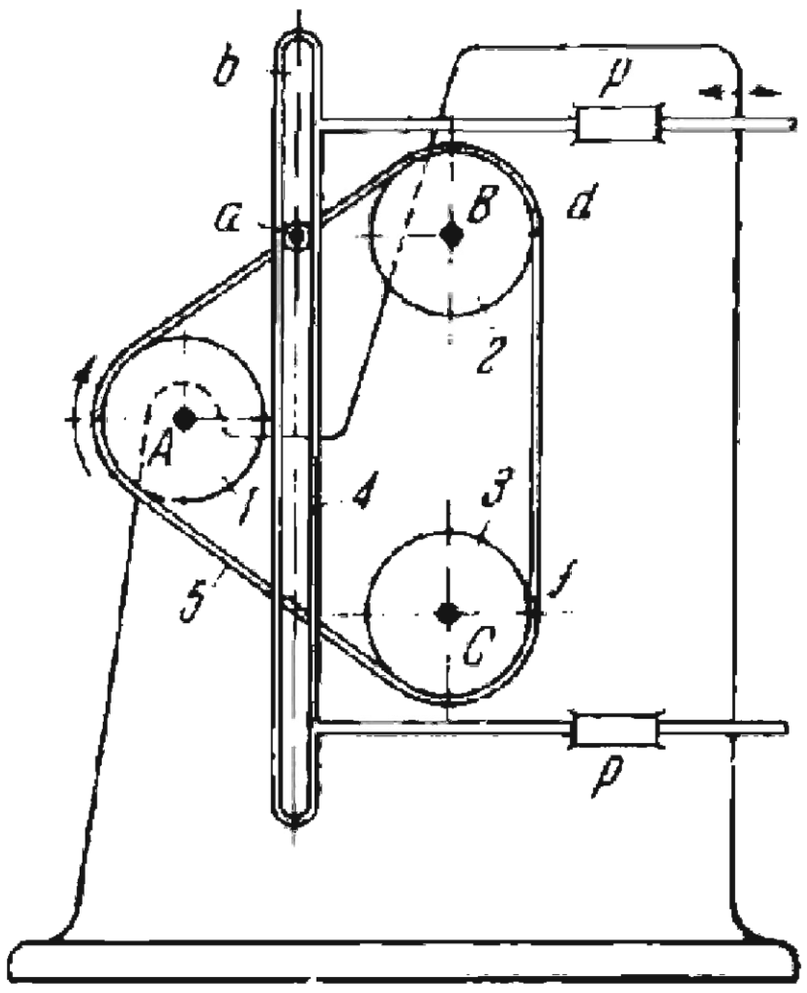


The lengths of the links comply with the conditions: the angle of inclination of slot *b* to guides *p-p* equals

$$\alpha = \arccos \frac{r_1 - r_2}{\overline{AB}}$$

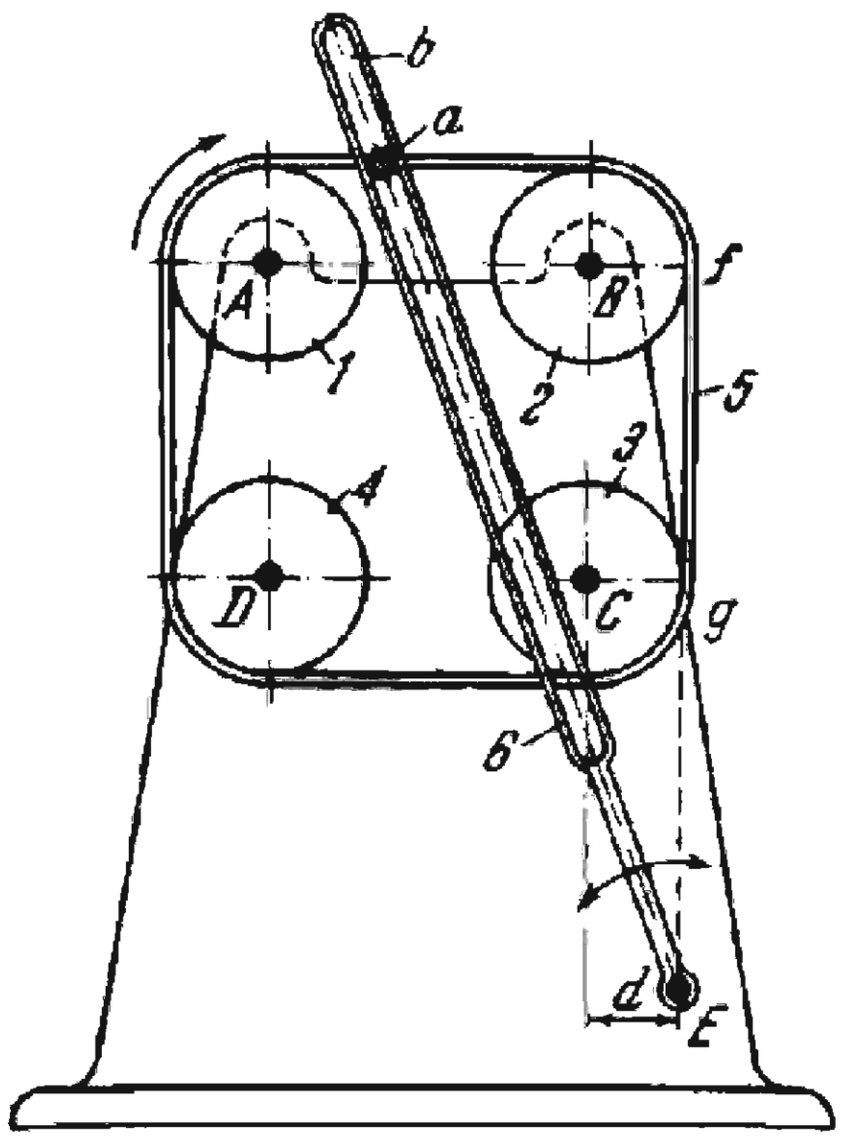
where r_1 and r_2 are the radii of pulleys *1* and *2*. Pulley *1* rotates about fixed axis *A* and, through flexible link *3*, rotates pulley *2* about fixed axis *B*. Pin *a* of flexible link *3* slides along slot *b* of slider *4* which moves in fixed guides *p-p*. When pulley *1* rotates about axis *A*, slider *4* reciprocates in guides *p-p*. When pin *a* travels along straight portion *df* of its path, slider *4* has a dwell in its right-hand extreme position.

1933	ARTOBOLEVSKY SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK AND A DWELL OF THE DRIVEN LINK	FL D



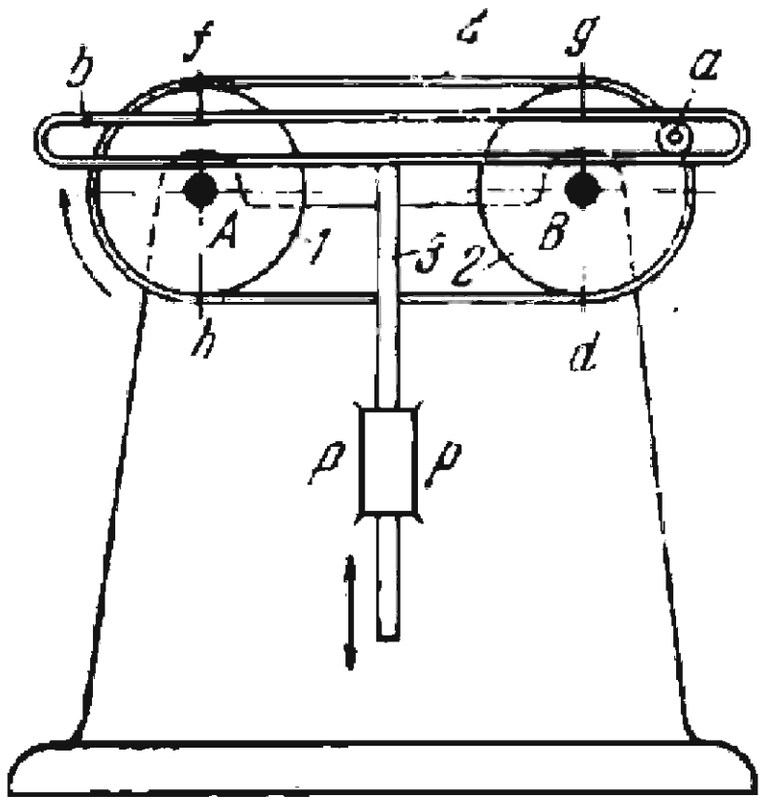
Pulleys *1*, *2* and *3* are of equal diameter. The axis of slot *b* of slider *4* is parallel to line *BC* and perpendicular to the axes of guides *p-p*. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulleys *2* and *3* about fixed axes *B* and *C*. Pin *a* of flexible link *5* slides along slot *b* of slider *4* which moves in fixed guides *p-p*. When pulley *1* rotates about axis *A*, slider *4* reciprocates in guides *p-p*. When pin *a* travels along straight portion *df* of its path, slider *4* has a dwell in its right-hand extreme position.

1934	ARTOBOLEVSKY LINK-GEAR MECHANISM WITH A FLEXIBLE LINK AND A DWELL OF THE DRIVEN LINK	FL D



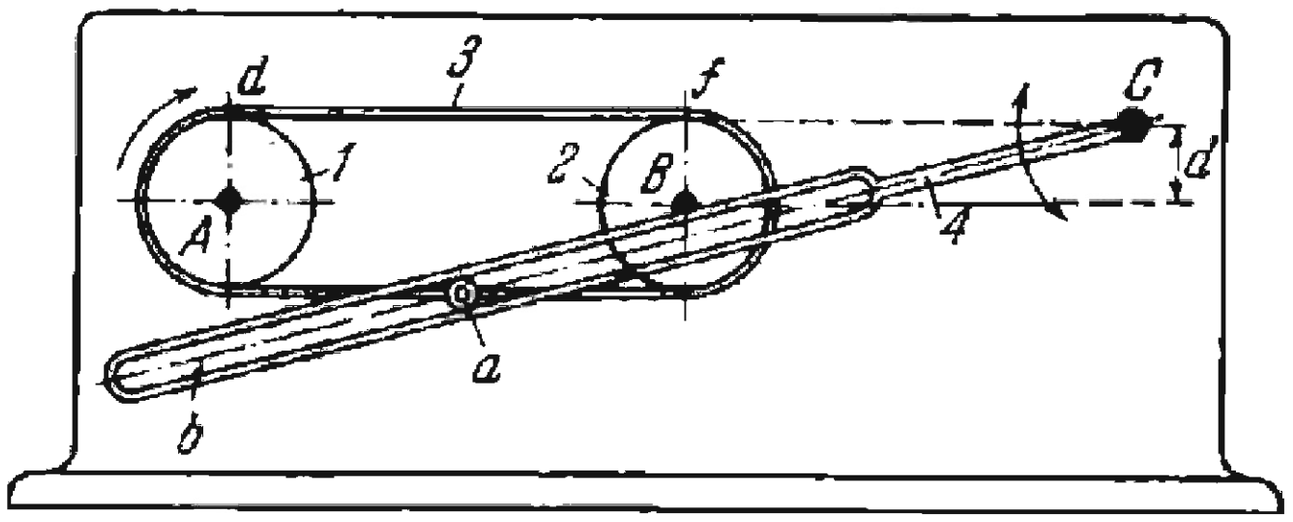
The lengths of the links comply with the conditions: $r_1 = r_2 = r_3 = r_4$, where r_1, r_2, r_3 and r_4 are the radii of pulleys *1*, *2*, *3* and *4*; $\overline{AB} = \overline{BC} = \overline{CD} = \overline{DA}$; and the distance between point *E* and line *BC* is $d = r_1$. Figure *ABCD* is a square. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulleys *2*, *3* and *4* about fixed axes *B*, *C* and *D*. Pin *a* of flexible link *5* slides along slot *b* of slotted link *6* which turns about fixed axis *E*. When pulley *1* rotates about axis *A*, slotted link *6* oscillates about axis *E*. When pin *a* travels along straight portion *fg* of its path, slotted link *6* has a dwell in its right-hand extreme position.

1935	ARTOBOLEVSKY SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK AND TWO DWELLS OF THE DRIVEN LINK	FL D



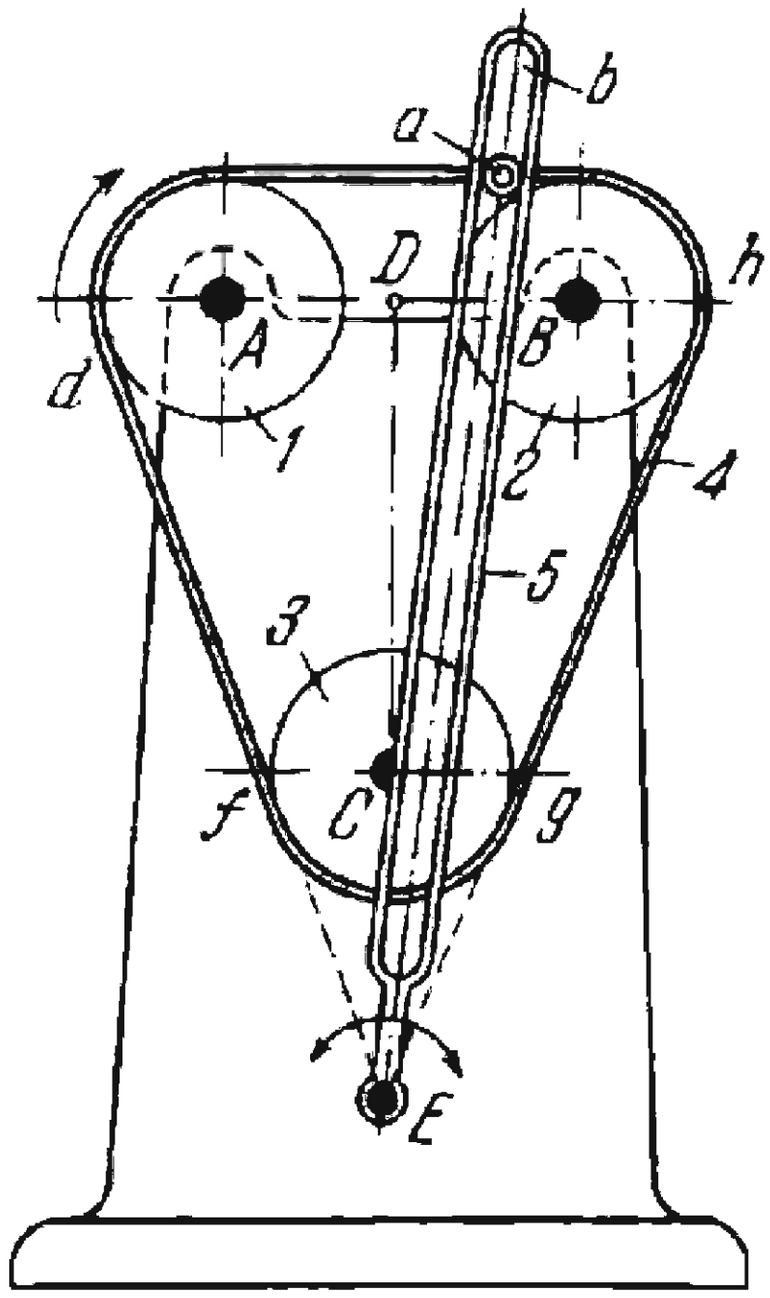
Pulleys *1* and *2* are of equal diameter. The axis of slot *b* in slider *3* is parallel to line *AB* and is perpendicular to the axis of guides *p-p*. Pulley *1* rotates about fixed axis *A* and, through flexible link *4*, rotates pulley *2* about fixed axis *B*. Pin *a* of flexible link *4* slides along slot *b* of slider *3* which moves in fixed guides *p-p*. When pulley *1* rotates about axis *A*, slider *3* reciprocates in guides *p-p*. When pin *a* travels along straight portions *fg* and *dh* of its path, slider *3* has two dwells: in its upper and lower extreme positions.

1936	ARTOBOLEVSKY LINK-GEAR MECHANISM WITH A FLEXIBLE LINK AND A DWELL OF THE DRIVEN LINK	FL D



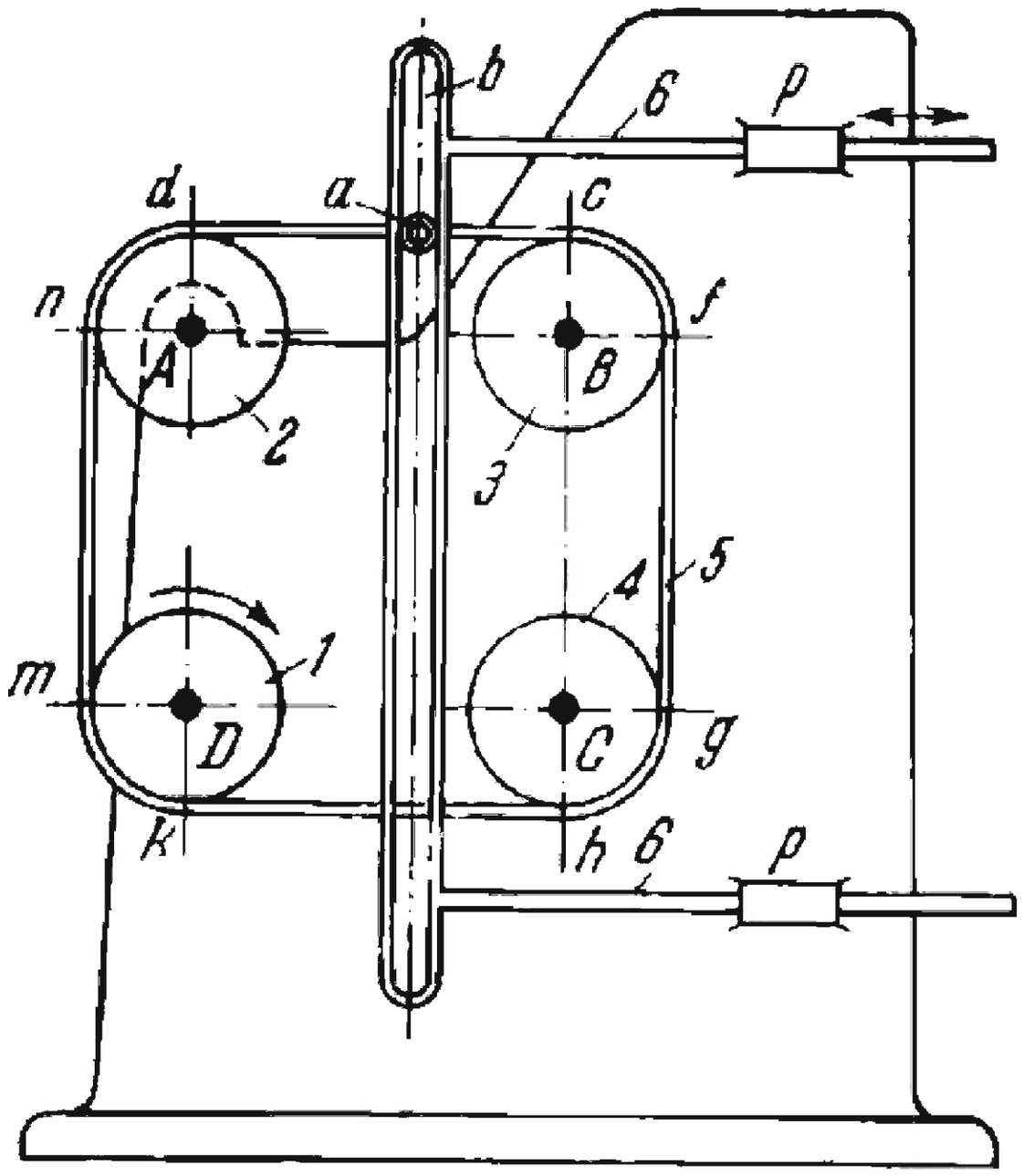
The lengths of the links comply with the conditions: $r_1 = r_2$, where r_1 and r_2 are the radii of pulleys *1* and *2*; and the distance from point *C* to line *AB* is $d = r_1$. Pulley *1* rotates about fixed axis *A* and, through flexible link *3*, rotates pulley *2* about fixed axis *B*. Pin *a* of flexible link *3* slides along slot *b* of slotted link *4* which turns about fixed axis *C*. When pulley *1* rotates about axis *A*, slotted link *4* oscillates about axis *C*. When pin *a* travels along straight portion *df* of its path, slotted link *4* has a dwell in its upper extreme position.

1937	ARTOBOLEVSKY LINK-GEAR MECHANISM WITH A FLEXIBLE LINK AND TWO DWELLS OF THE DRIVEN LINK	FL D



The lengths of the links comply with the conditions: $r_1 = r_2 = r_3$, where r_1, r_2 and r_3 are the radii of pulleys *1*, *2* and *3*; $\overline{AD} = \overline{DB}$; $\overline{AC} = \overline{BC}$ and $\overline{CE} = \frac{\overline{BC}}{\overline{AD}} r_1$. Pulley *1* rotates about fixed axis *A* and, through flexible link *4*, rotates pulleys *2* and *3* about fixed axes *B* and *C*. Pin *a* of flexible link *4* slides along slot *b* of slotted link *5* which turns about fixed axis *E*. When pulley *1* rotates about axis *A*, slotted link *5* oscillates about axis *E*. When pin *a* travels along straight portions *hg* and *fd* of its path, slotted link *5* has two dwells in its extreme positions.

1938	ARTOBOLEVSKY SLIDER-CRANK MECHANISM WITH A FLEXIBLE LINK AND TWO DWELLS OF THE DRIVEN LINK	FL D



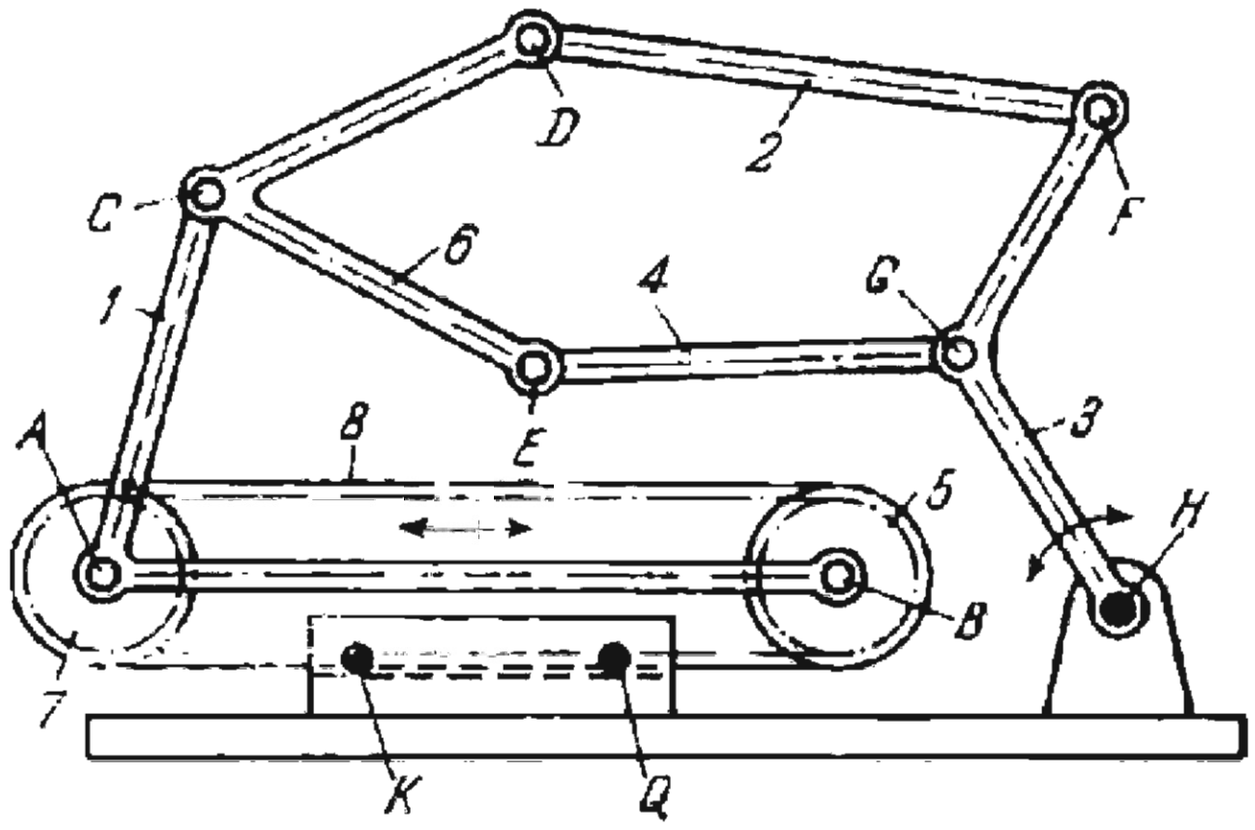
The lengths of the links comply with the conditions: $r_1 = r_2 = r_3 = r_4$, where r_1, r_2, r_3 and r_4 are the radii of pulleys *1*, *2*, *3* and *4*; and $\overline{AB} = \overline{BC} = \overline{CD} = \overline{DA}$. Figure $ABCD$ is a square. Pulley *1* rotates about fixed axis D and, through flexible link *5*, rotates pulleys *2*, *3* and *4* about fixed axes A, B and C. Pin a of flexible link *5* slides along slot b of slider *6* which moves in fixed guides p-p. When pulley *1* rotates about axis D, slider *6* reciprocates in guides p-p. If line AB is parallel to the axes of guides p-p, line BC is parallel to the axis of slot b and pulley *1* rotates at constant angular velocity ω, then, when pin a travels along straight portions dc and hk of its path, slider *4* travels at constant velocity equal to

$$v = \omega r_1.$$

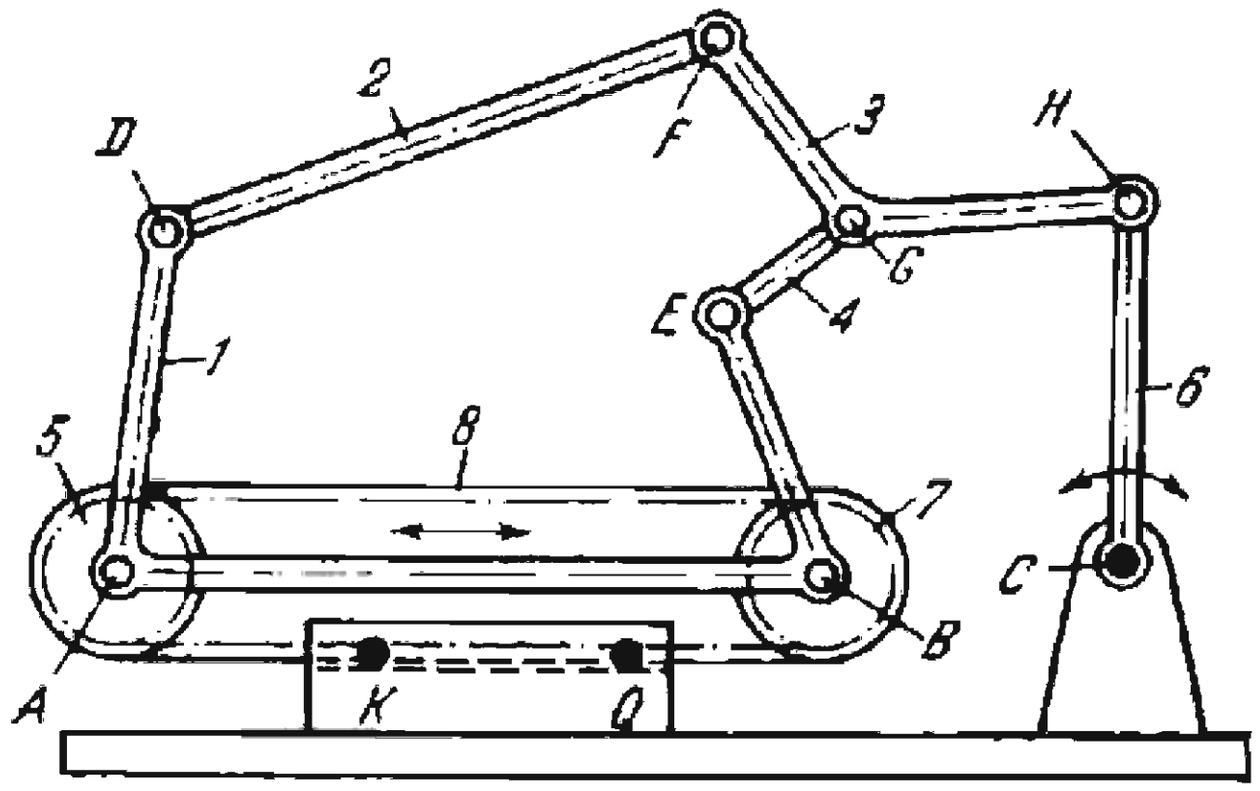
When pin a travels along straight portions fg and mn of its path, slider *4* has two dwells in its extreme positions.

6. CRAWLER MECHANISMS (1939 through 1970)

1939	HAIN LINKWORK CRAWLER MECHANISM	FL Cr

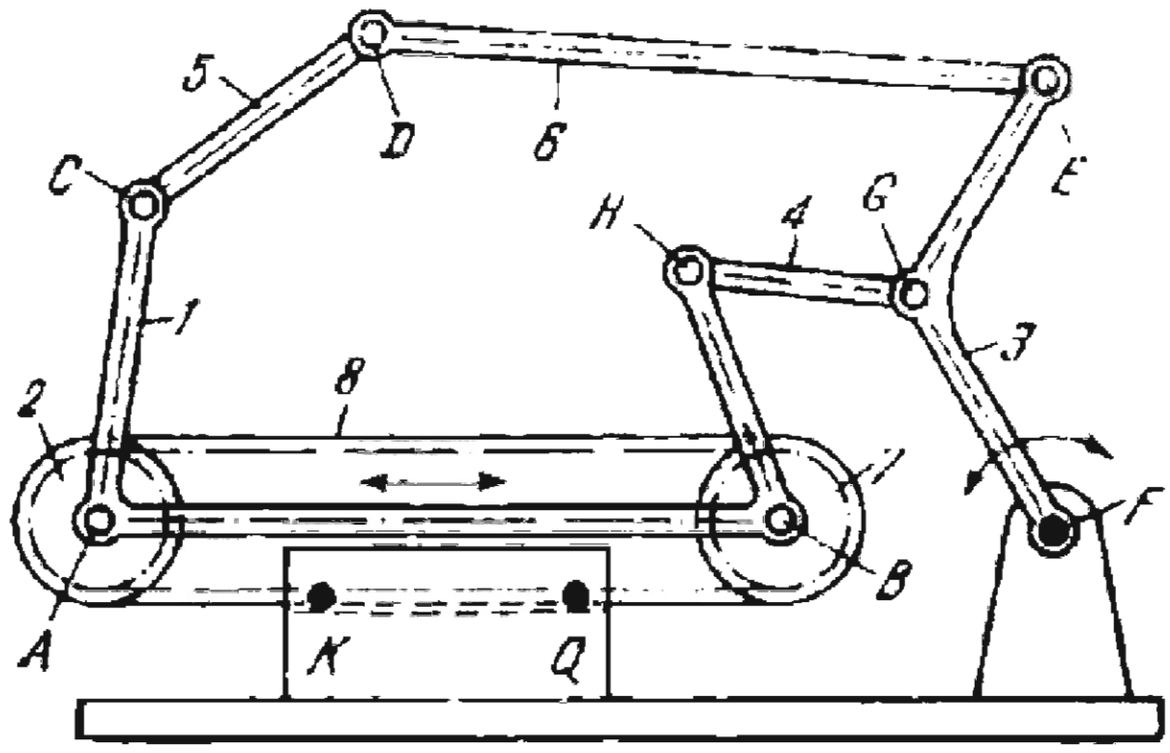


Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *5*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *6*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to links *1*, *2* and *4*. Link *3*, designed as a bent lever, turns about fixed axis *H* and is connected by turning pairs *G* and *F* to links *4* and *2*. When link *1* has straight translational motion, links *2*, *4* and *6* have complex motions and link *3* oscillates about axis *H*.



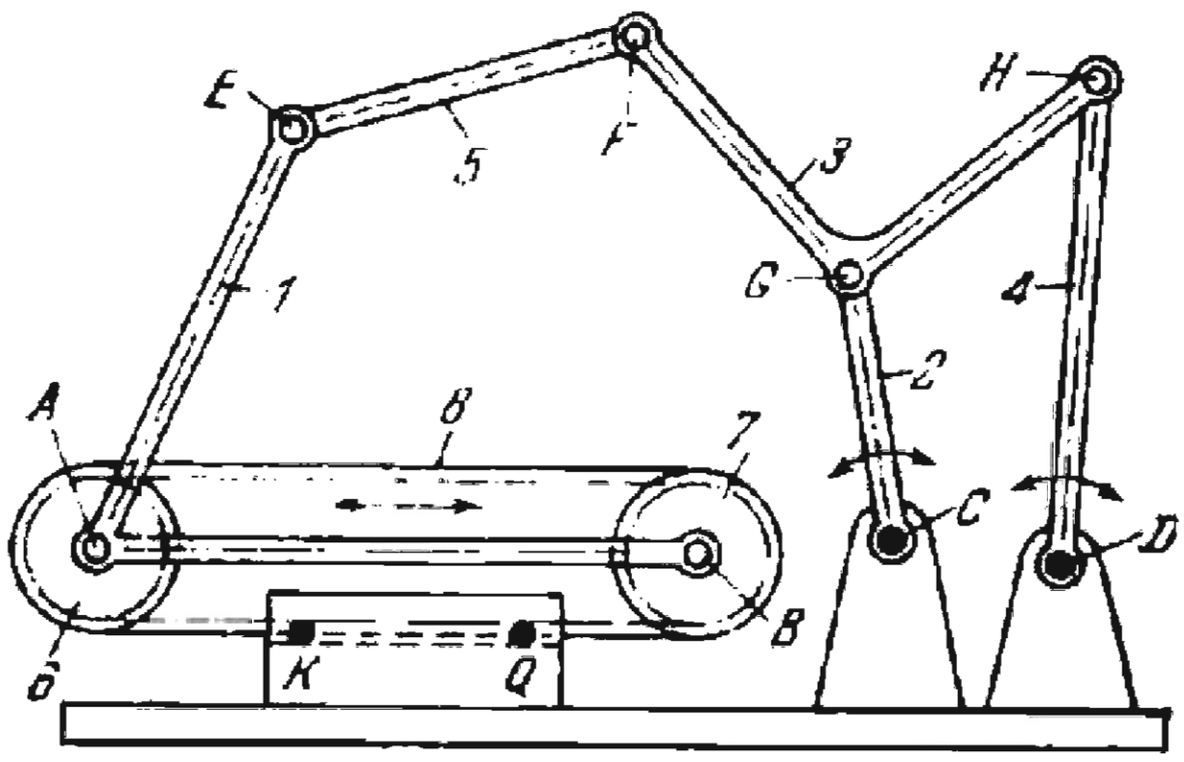
Link *1*, designed as a complex lever, is connected by turning pairs *A* and *B* to pulleys *5* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *2* is connected by turning pairs *D* and *F* to links *1* and *3*, the latter being designed as a bent lever. Link *4* is connected by turning pairs *E* and *G* to links *1* and *3*. Link *6* turns about fixed axis *C* and is connected by turning pair *H* to link *3*. When link *1* has straight translational motion, links *2*, *3* and *4* have complex motion and link *6* oscillates about axis *C*.

1941	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



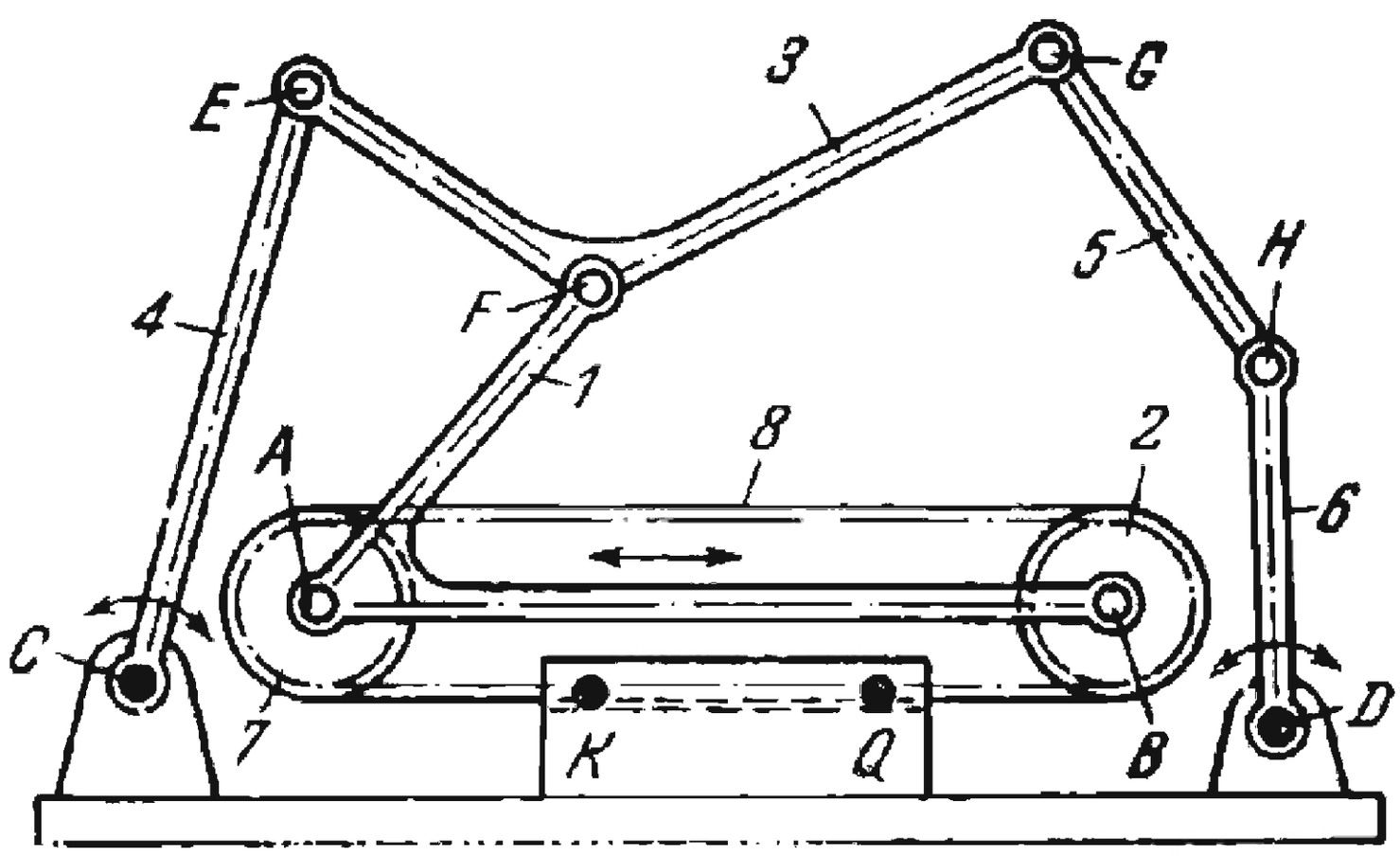
Link *1*, designed as a complex lever, is connected by turning pairs *A* and *B* to pulleys *2* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *5* is connected by turning pairs *C* and *D* to links *1* and *6*. Link *4* is connected by turning pairs *H* and *G* to links *1* and *3*. Link *3*, designed as a bent lever, turns about fixed axis *F* and is connected by turning pair *E* to link *6*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motion to links *4*, *5* and *6*, and link *3* oscillates about axis *F*.

1942	HAIN LINKWORK CRAWLER MECHANISM	FL Cr

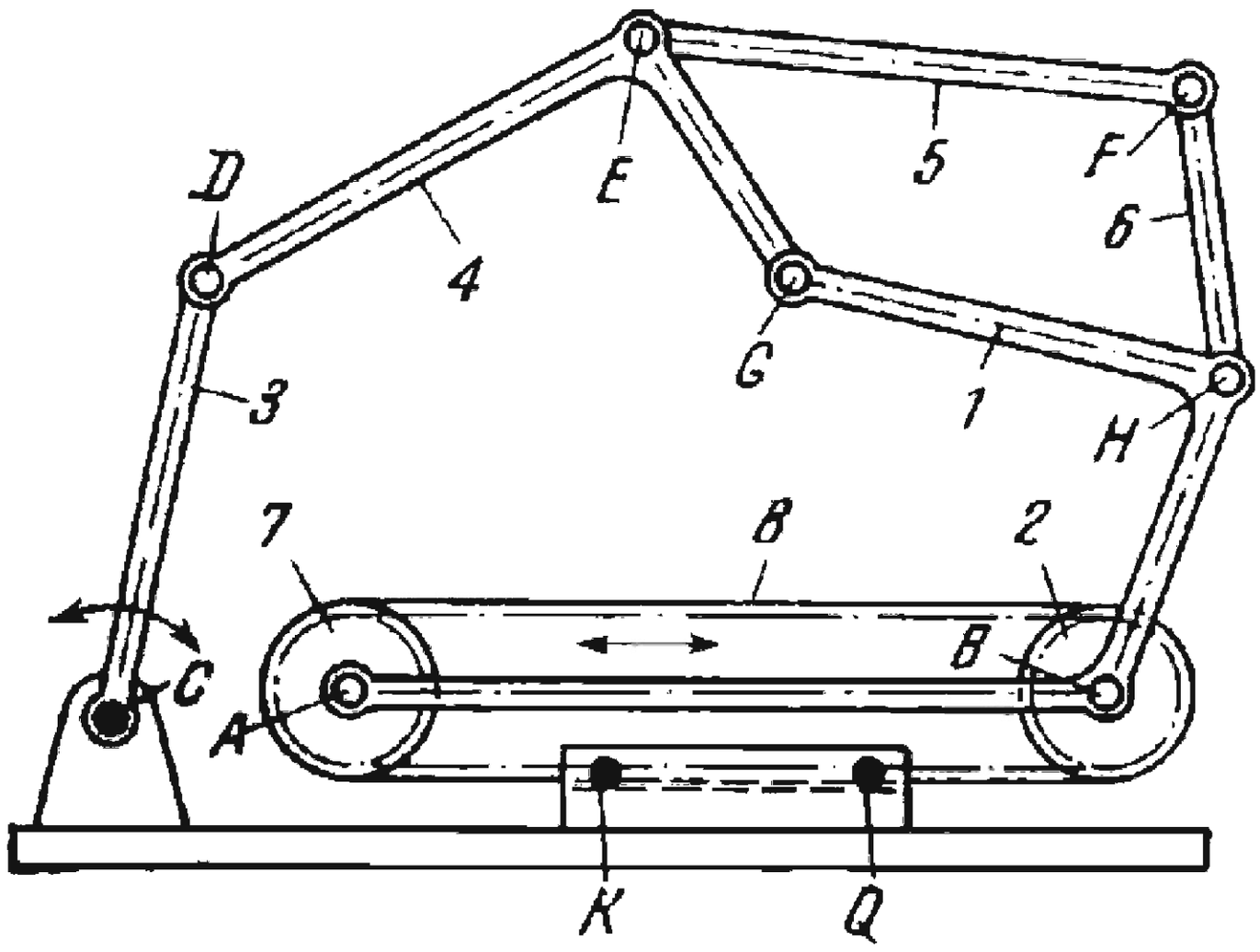


Link *1* is connected by turning pairs *A* and *B* to pulleys *6* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *5* is connected by turning pairs *E* and *F* to links *1* and *3*. Link *3*, designed as a bent lever, is connected by turning pairs *G* and *H* to links *2* and *4* which turn about fixed axes *C* and *D*. When link *1* has straight translational motion, links *3* and *5* have complex motions and links *2* and *4* oscillate about axes *C* and *D*.

1943	HAIN LINKWORK CRAWLER MECHANISM	FL Cr

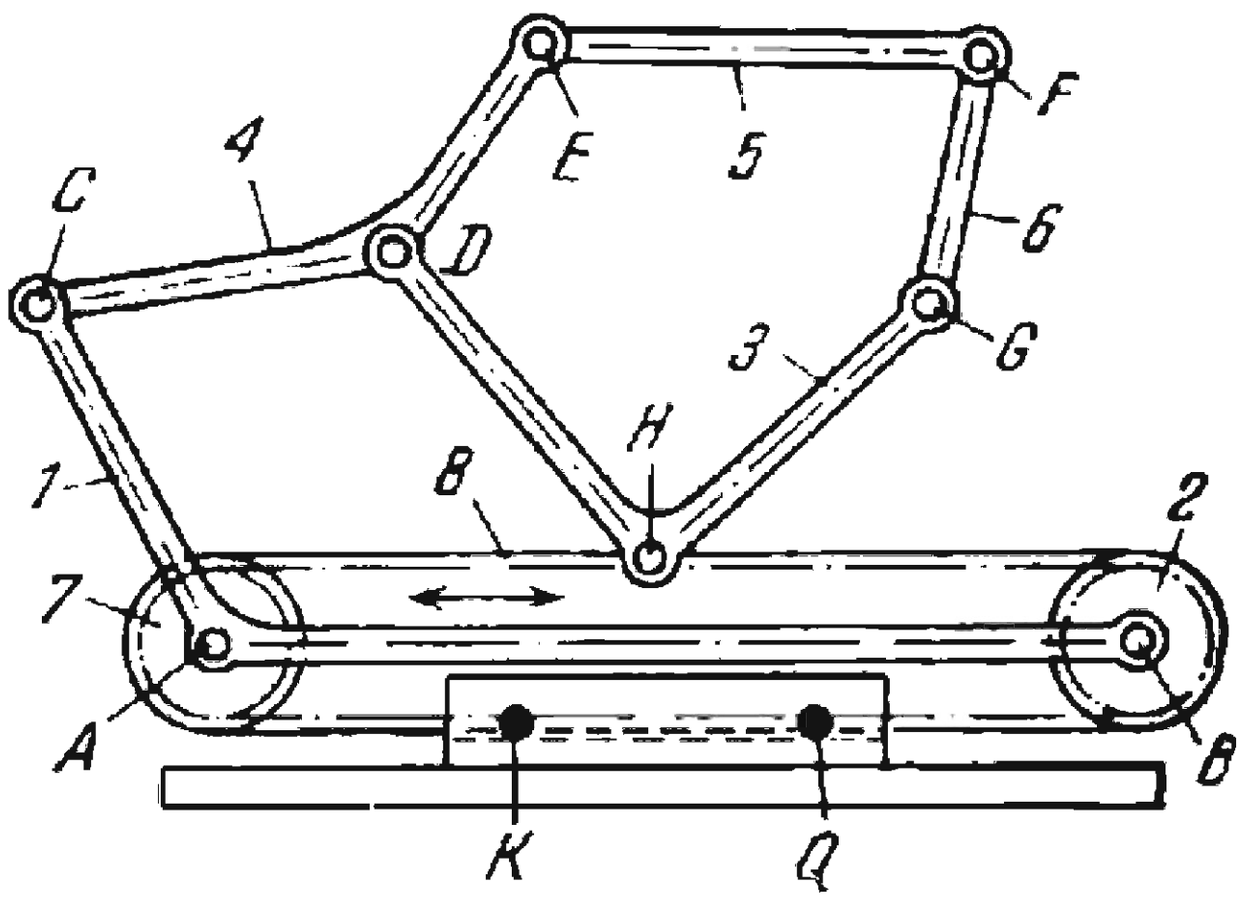


Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *2*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *3*, designed as a bent lever, is connected by turning pairs *F*, *G* and *E* to links *1*, *5* and *4*. Links *4* and *6* turn about fixed axes *C* and *D*. Link *5* is connected by turning pair *H* to link *6*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *3* and *5*, and links *4* and *6* oscillate about axes *C* and *D*.



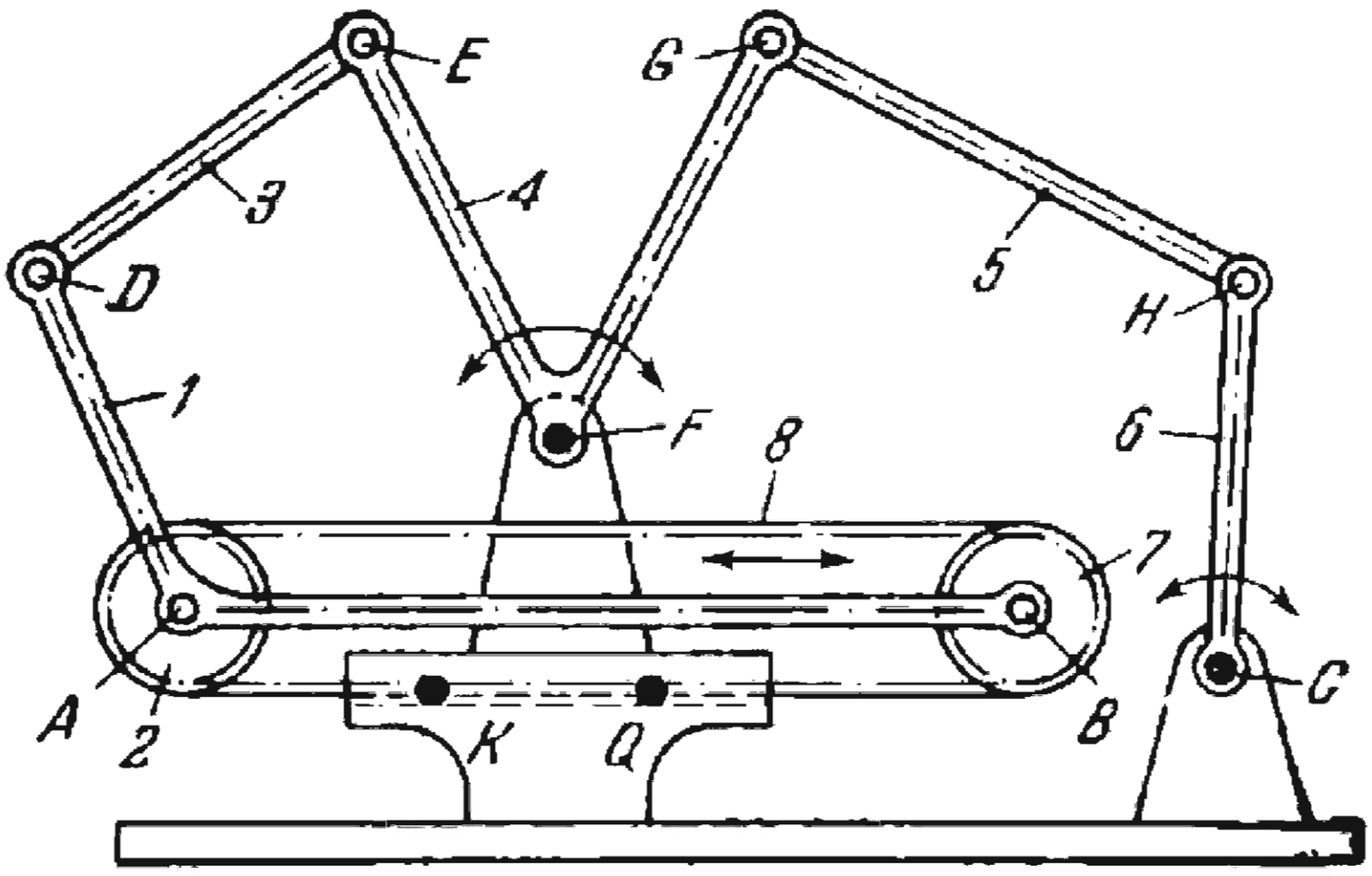
Link *1*, designed as a complex lever, is connected by turning pairs *A* and *B* to pulleys *7* and *2*, of equal diameter, and by turning pairs *H* and *G* to links *6* and *4*. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *4*, designed as a bent lever, is connected by turning pairs *E* and *D* to link *5* and to link *3* which turns about fixed axis *C*. Links *6* and *5* are connected together by turning pair *F*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *4*, *5* and *6*, and link *3* oscillates about axis *C*.

1945	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



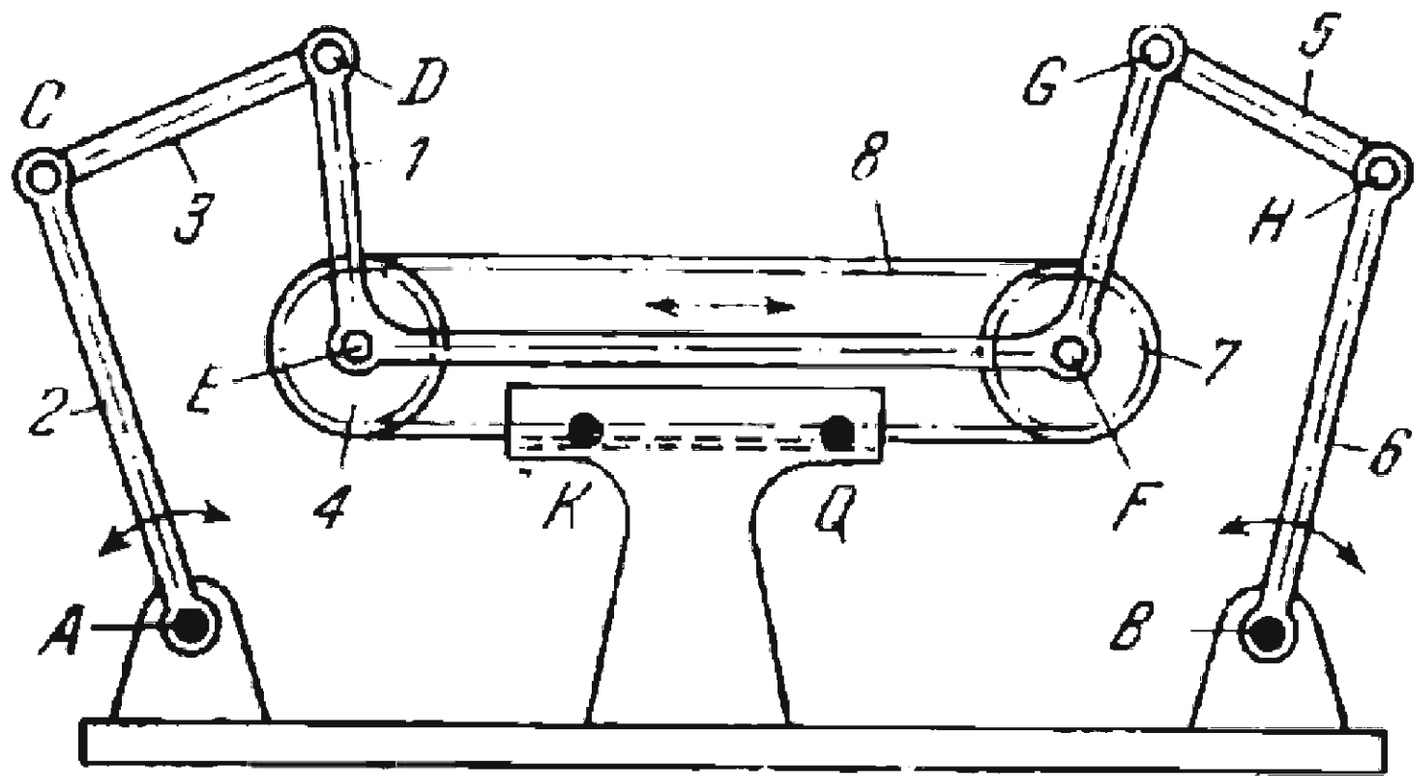
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *2*, of equal diameter, and by turning pair *C* to link *4*. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *4*, designed as a bent lever, is connected by turning pairs *D* and *E* to links *3* and *5*. Link *3*, designed as a bent lever, is connected by turning pairs *H* and *G* to flexible link *8* and to link *6*. Links *5* and *6* are connected together by turning pair *F*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *3*, *4*, *5* and *6*.

1946	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



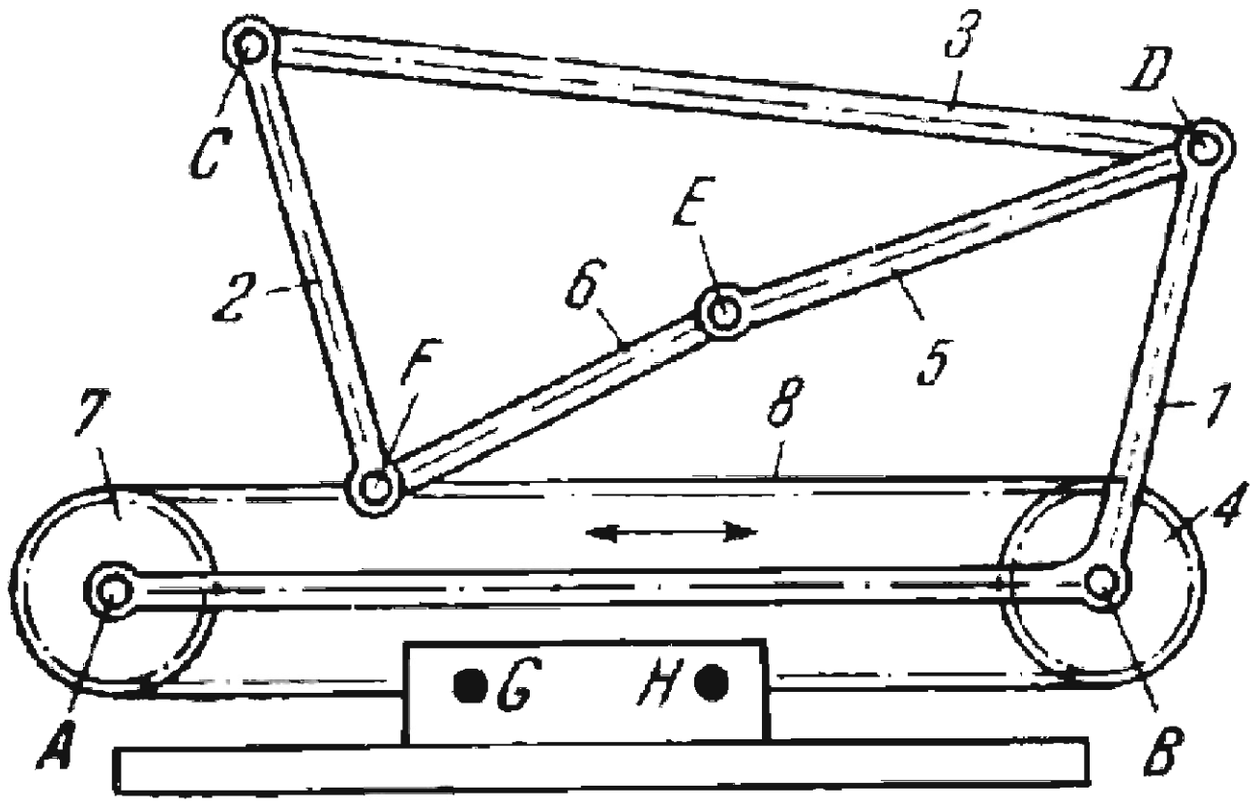
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *2* and *7*, of equal diameter, and by turning pair *D* to link *3*. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Link *4*, designed as a bent lever, turns about fixed axis *F* and is connected by turning pairs *E* and *G* to links *3* and *5*. Link *6* turns about fixed axis *C* and is connected by turning pair *H* to link *5*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *3* and *5*, and links *4* and *6* oscillate about axes *F* and *C*.

1947	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



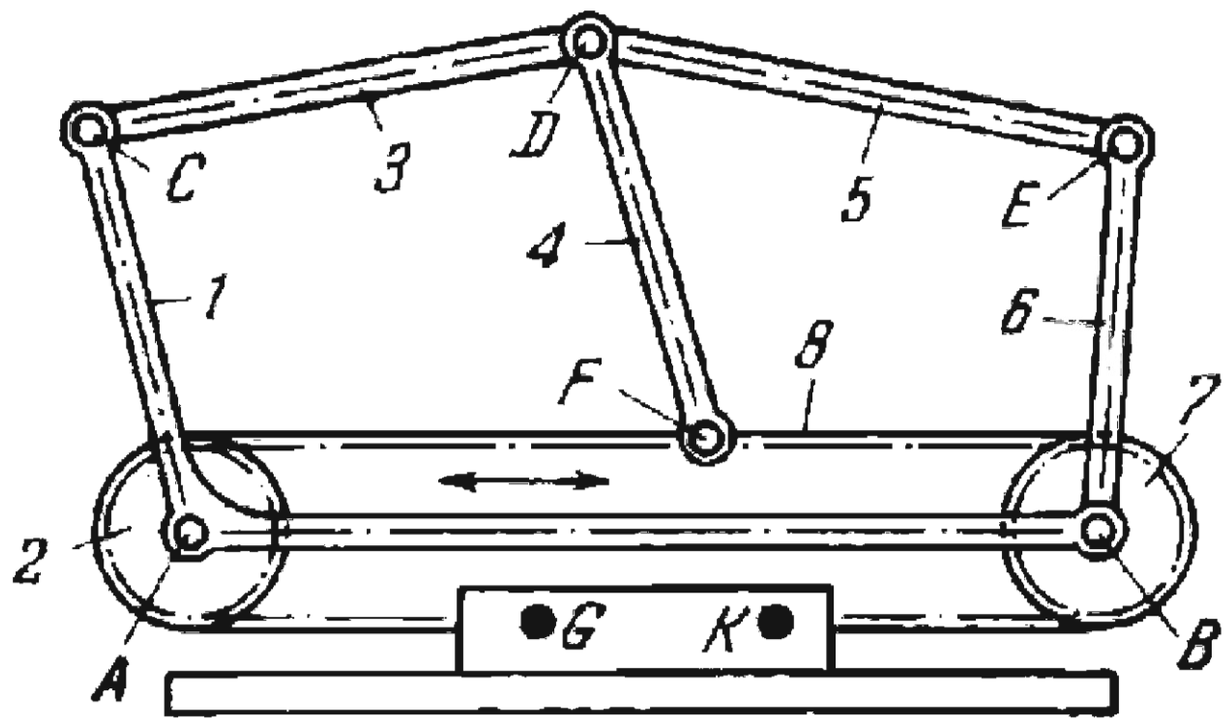
Link *1*, designed as a complex lever, is connected by turning pairs *E* and *F* to pulleys *4* and *7*, of equal diameter, and by turning pairs *D* and *G* to links *3* and *5*. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *Q* to the base. Links *2* and *6* turn about fixed axes *A* and *B* and are connected by turning pairs *C* and *H* to links *3* and *5*. When link *1* has straight translational motion, pulleys *4* and *7* roll along flexible link *8*, imparting complex motions to links *3* and *5*, and links *2* and *6* oscillate about axes *A* and *B*.

1948	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



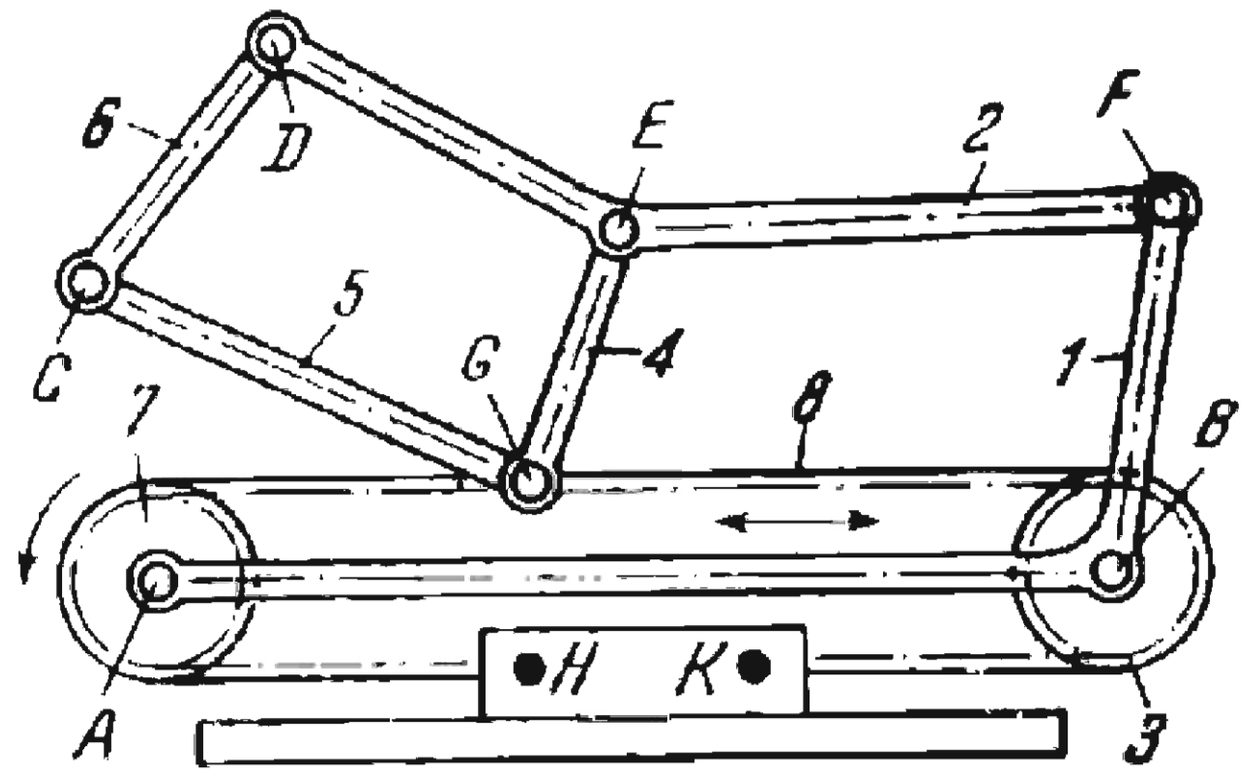
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *4*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *G* and *H* to the base. Link *3* is connected by turning pairs *C* and *D* to links *2*, *1* and *5*. Links *2* and *6* are connected by turning pairs *F* to flexible link *8*. Links *5* and *6* are connected together by turning pair *E*. When link *1* has straight translational motion, links *2*, *3*, *5* and *6* have complex motions.

1949	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



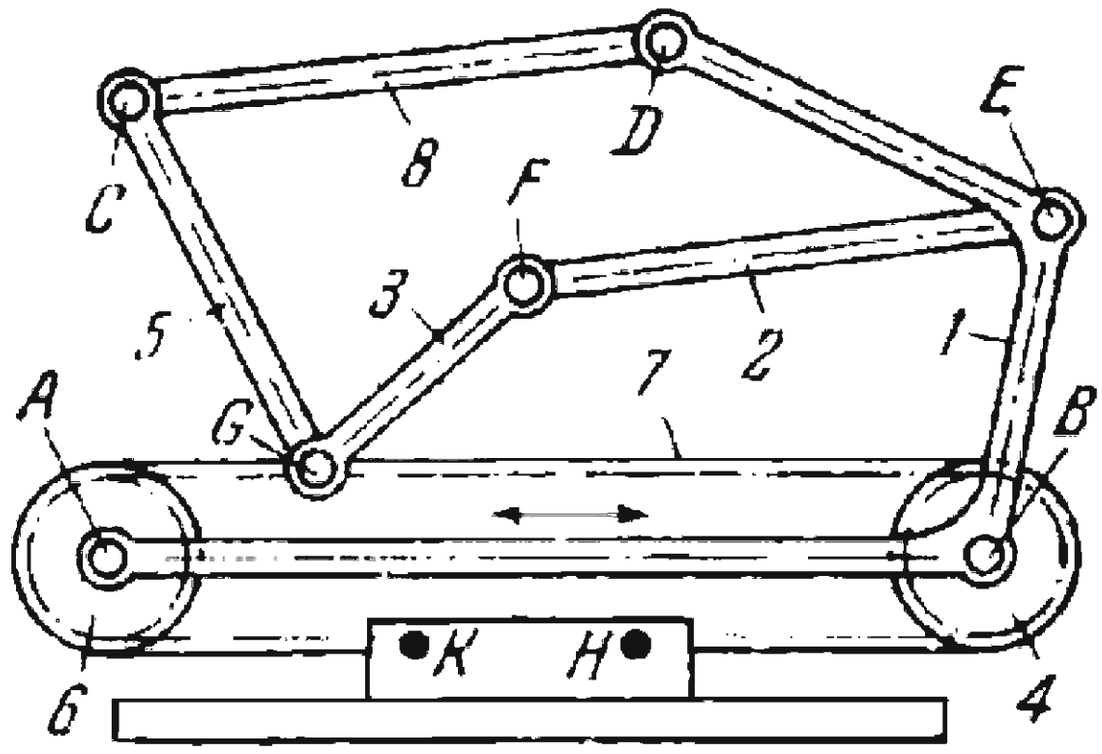
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *2* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *G* and *K* to the base. Link *3* is connected by turning pairs *C* and *D* to link *1* and to links *4* and *5*. Link *4* is connected by turning pair *F* to flexible link *8*. Link *6* is connected by turning pairs *B* and *E* to links *1* and *5*. When link *1* has straight translational motion, links *3*, *4*, *5* and *6* have complex motions.

1950	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



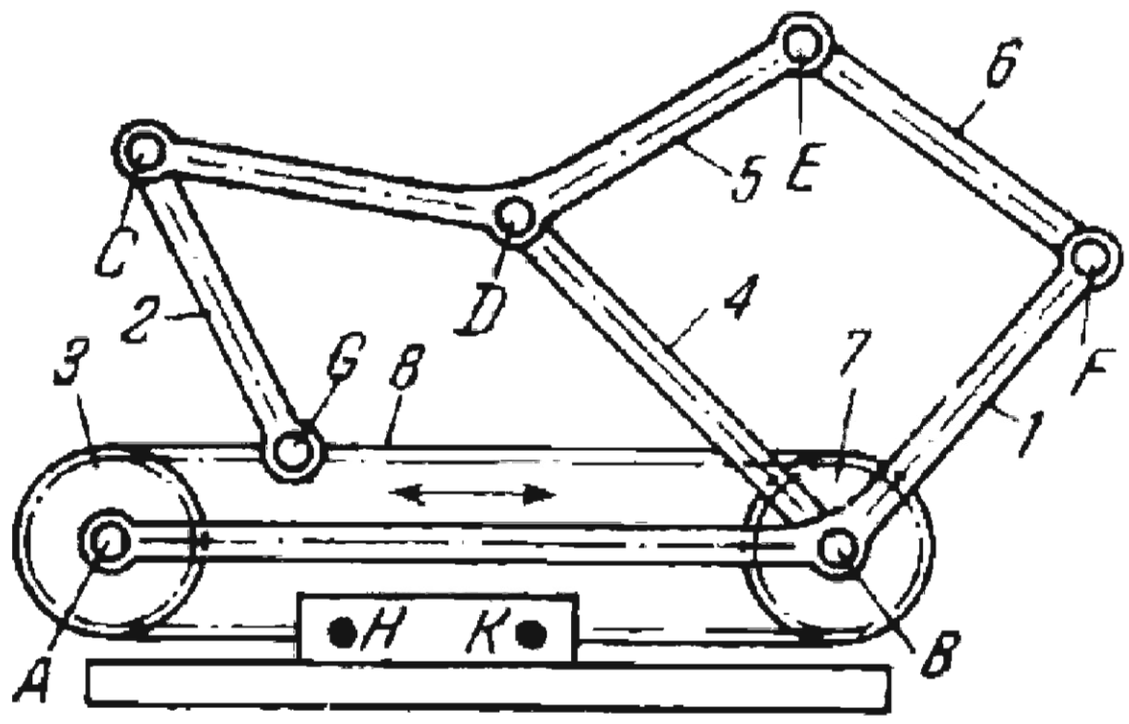
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *3*, of equal diameter, and by turning pair *F* to link *2* which is designed as a bent lever. Flexible link *8* runs over the pulleys and is rigidly secured at points *H* and *K* to the base. Links *4* and *5* are connected by turning pairs *G* to flexible link *8* and by turning pairs *E* and *C* to links *2* and *6*. Links *6* and *2* are connected together by turning pair *D*. When link *1* has straight translational motion, links *2*, *4*, *5* and *6* have complex motions.

1951	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



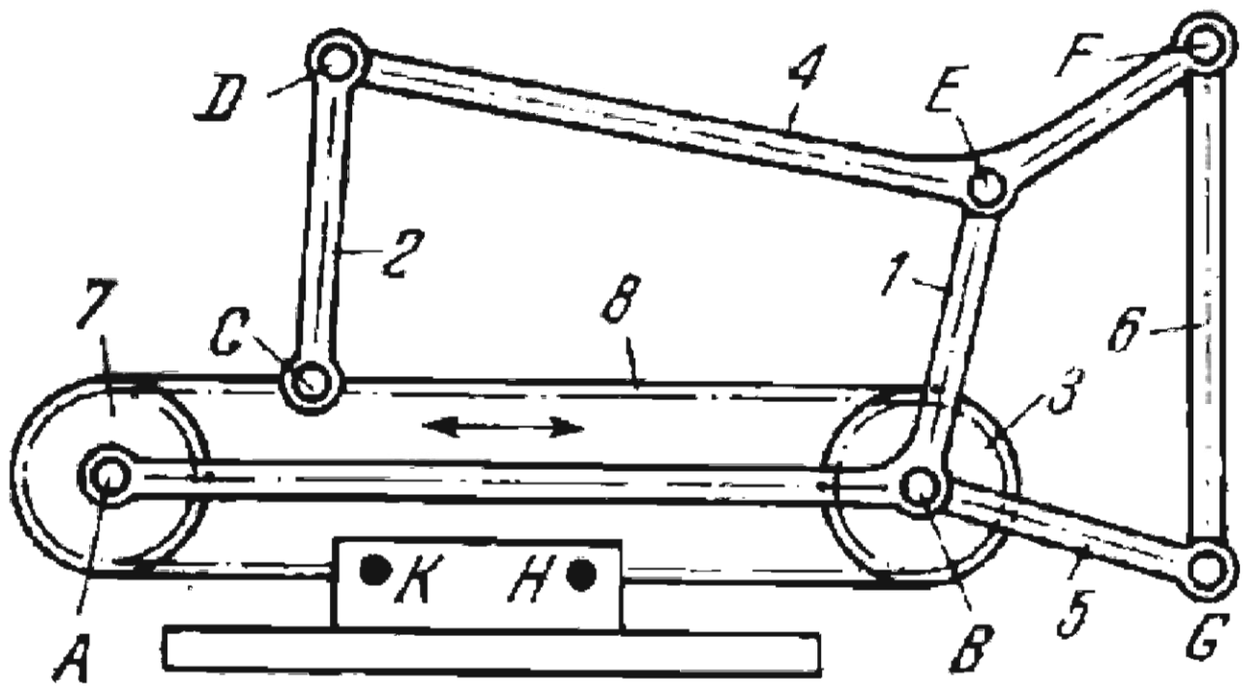
Link *1*, designed as a complex lever, is connected by turning pairs *A* and *B* to pulleys *6* and *4*, of equal diameter. Flexible link *7* runs over the pulleys and is rigidly secured at points *K* and *H* to the base. Links *2* and *8* are connected by turning pairs *E* and *D* to link *1* and by turning pairs *F* and *C* to links *3* and *5*, which, in turn, are connected by turning pairs *G* to flexible link *7*. When link *1* has straight translational motion, pulleys *4* and *6* roll along flexible link *7*, imparting complex motions to links *2*, *3*, *5* and *8*.

1952	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



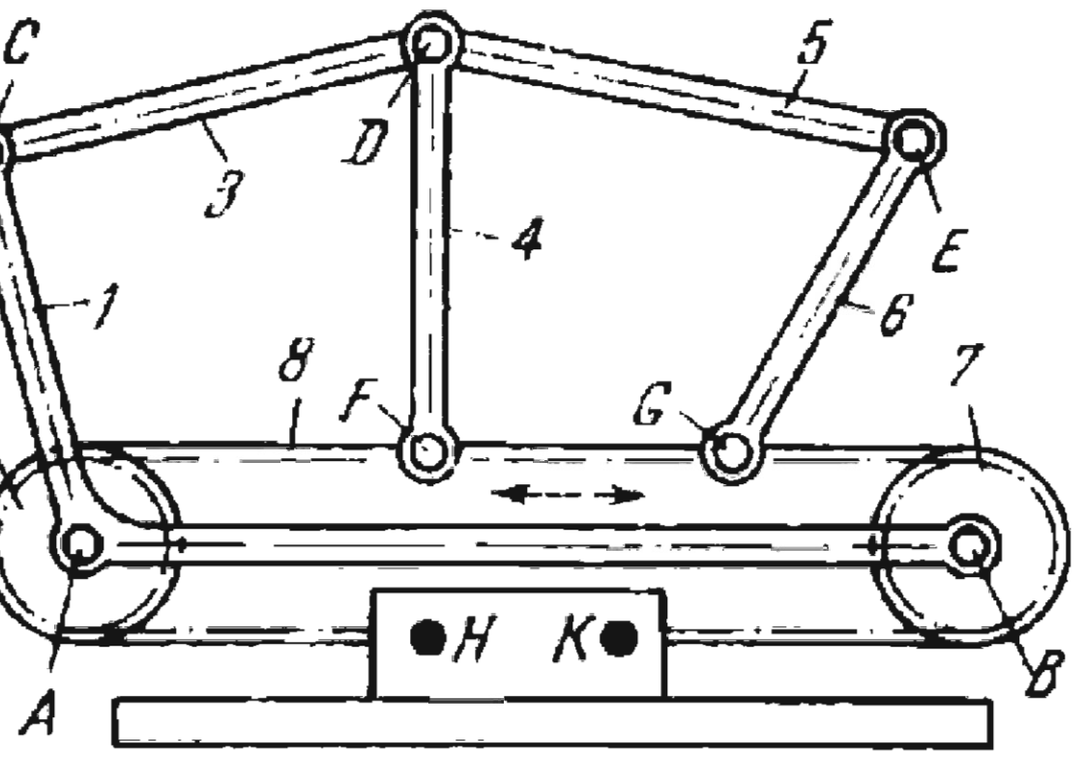
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *3* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *H* and *K* to the base. Link *5*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to links *2*, *4* and *6*. Links *2*, *4* and *6* are connected by turning pairs *G*, *B* and *F* to flexible link *8* and to link *1*. When link *1* has straight translational motion, pulleys *3* and *7* roll along flexible link *8*, imparting complex motions to links *2*, *4*, *5* and *6*.

1953	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



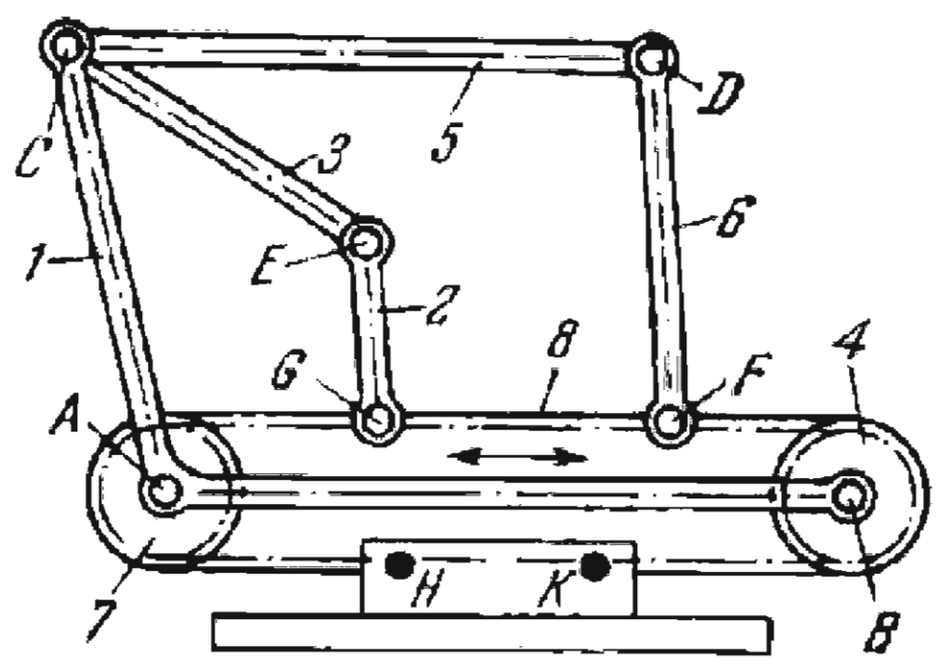
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *3*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *K* and *H* to the base. Link *4*, designed as a bent lever, is connected by turning pairs *D*, *E* and *F* to links *2*, *1* and *6*. Links *2* and *6* are connected by turning pairs *C* and *G* to flexible link *8* and to link *5* which, in turn, is connected by turning pairs *B* to link *1* and pulley *3*. When link *1* has straight translational motion, pulleys *3* and *7* roll along flexible link *8*, imparting complex motions to links *2*, *4*, *5* and *6*.

1954	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



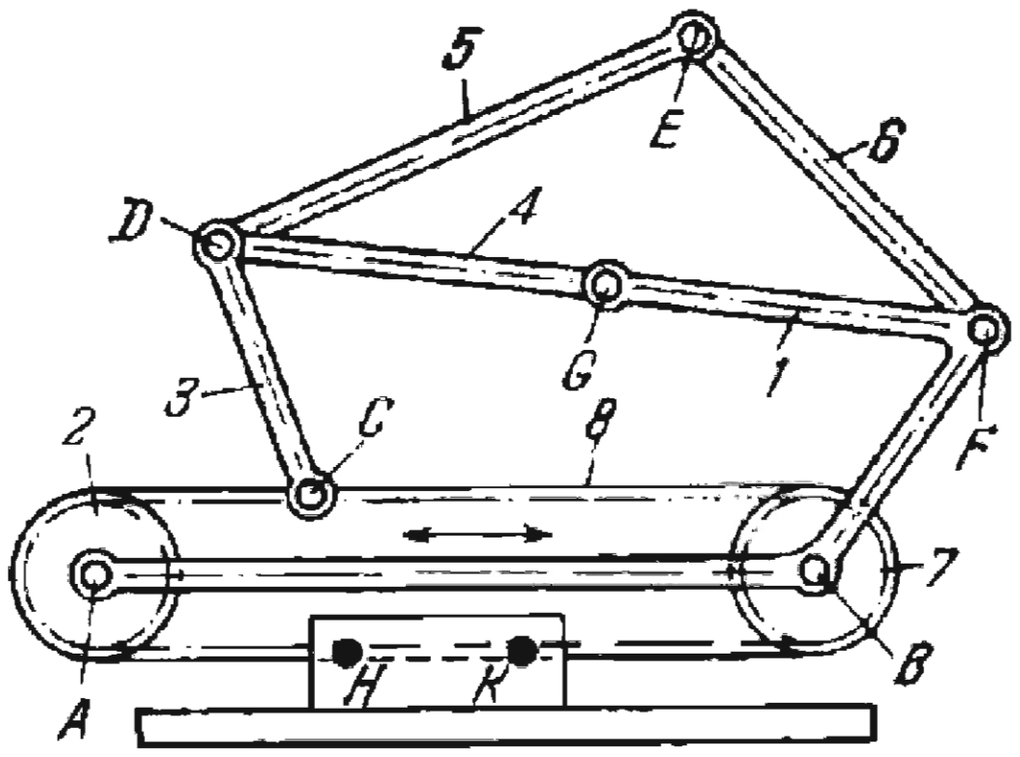
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *2* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *H* and *K* to the base. Link *3* is connected by turning pairs *C* and *D* to links *1*, *4* and *5*. Links *4* and *6* are connected by turning pairs *F* and *G* to flexible link *8* and by turning pairs *D* and *E* to link *5*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *3*, *4*, *5* and *6*.

1955	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



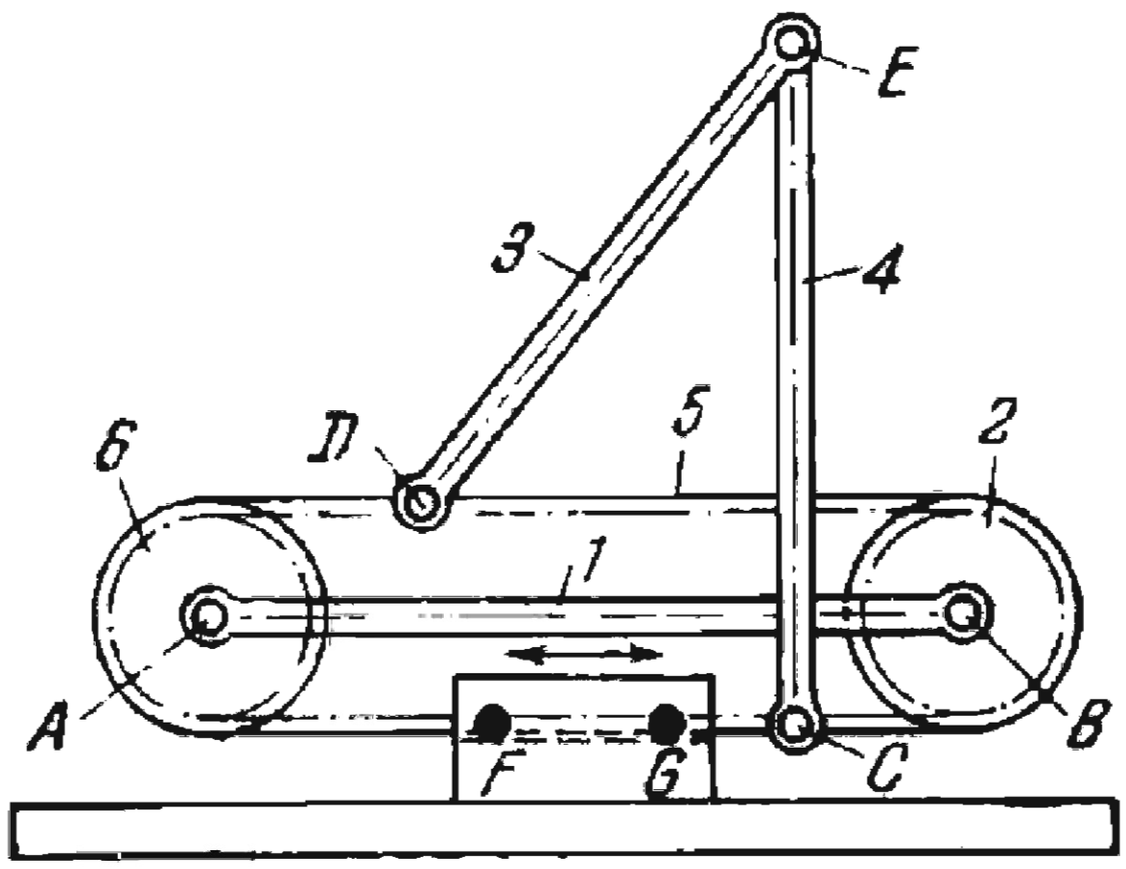
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *4*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *H* and *K* to the base. Links *3* and *5* are connected by turning pairs *C* to link *1* and by turning pairs *E* and *D* to links *2* and *6* which, in turn, are connected by turning pairs *G* and *F* to flexible link *8*. When link *1* has straight translational motion, pulleys *4* and *7* roll along flexible link *8*, imparting complex motions to links *2*, *3*, *5* and *6*.

1956	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



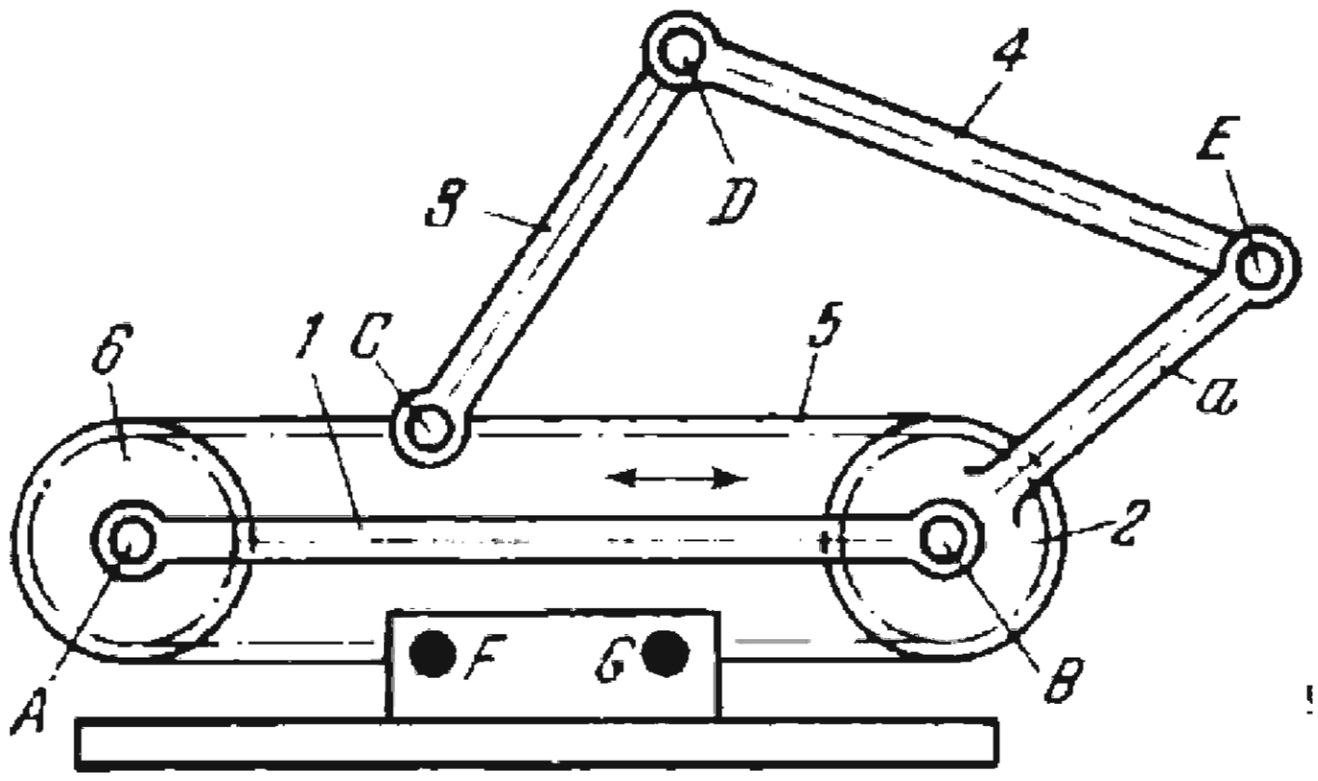
Link *1*, designed as a complex lever, is connected by turning pairs *A* and *B* to pulleys *2* and *7*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *H* and *K* to the base. Link *3* is connected by turning pairs *C* and *D* to flexible link *8* and to links *4* and *5*. Links *4* and *6* are connected by turning pairs *G* and *F* to link *1*. Links *5* and *6* are connected together by turning pair *E*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *3*, *4*, *5* and *6*.

1957	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



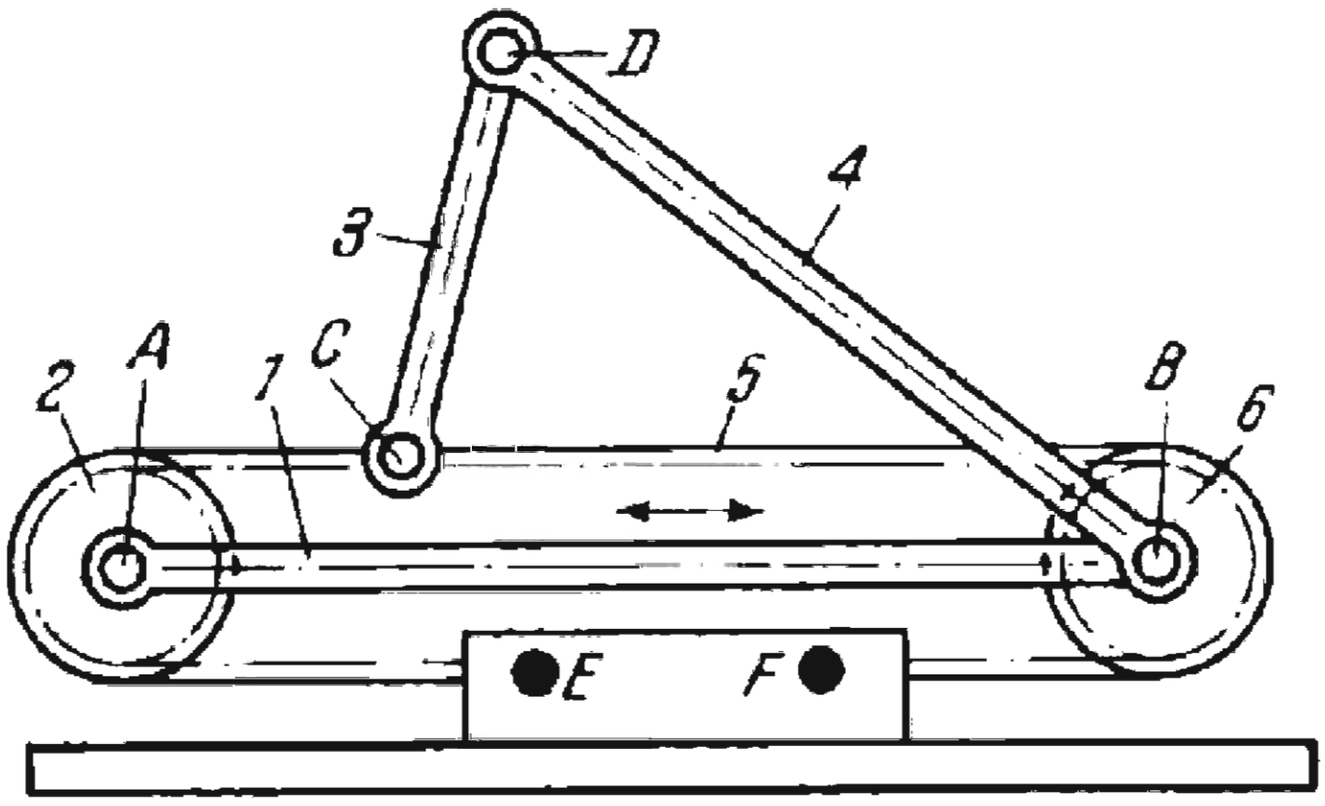
Link *1* is connected by turning pairs *A* and *B* to pulleys *6* and *2*, of equal diameter. Flexible link *5* runs over the pulleys and is rigidly secured at points *F* and *G* to the base. Links *3* and *4* are connected together by turning pair *E* and to flexible link *5* by turning pairs *D* and *C*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *5*, imparting complex motions to links *3* and *4*.

1958	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



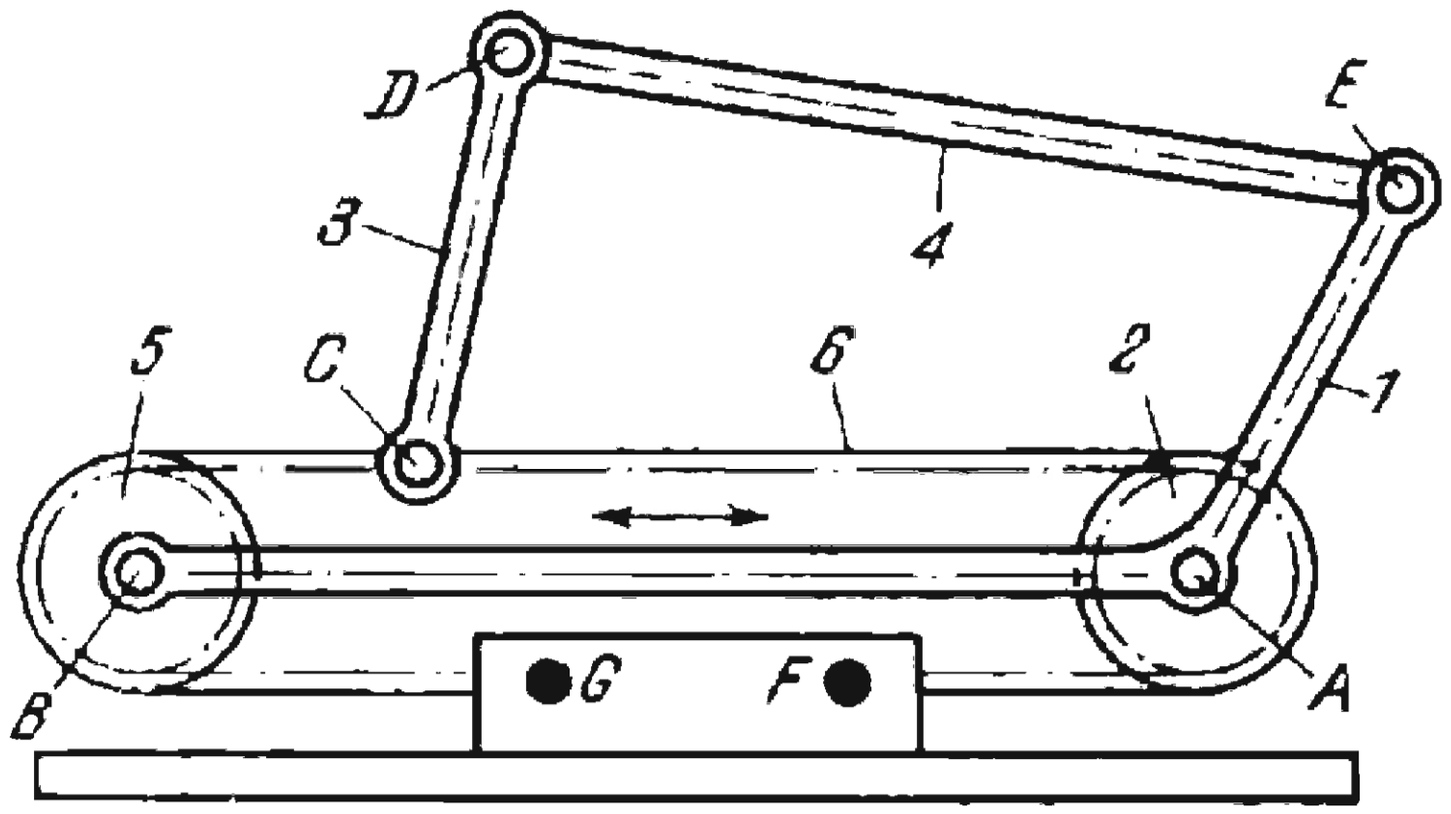
Link *1* is connected by turning pairs *A* and *B* to pulleys *6* and *2*, of equal diameter. Flexible link *5* runs over the pulleys and is rigidly secured at points *F* and *G* to the base. Link *3* is connected by turning pairs *C* and *D* to flexible link *5* and to link *4* which, in turn, is connected by turning pair *E* to extension *a* of pulley *2*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *5*, imparting complex motions to links *3* and *4*.

1959	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



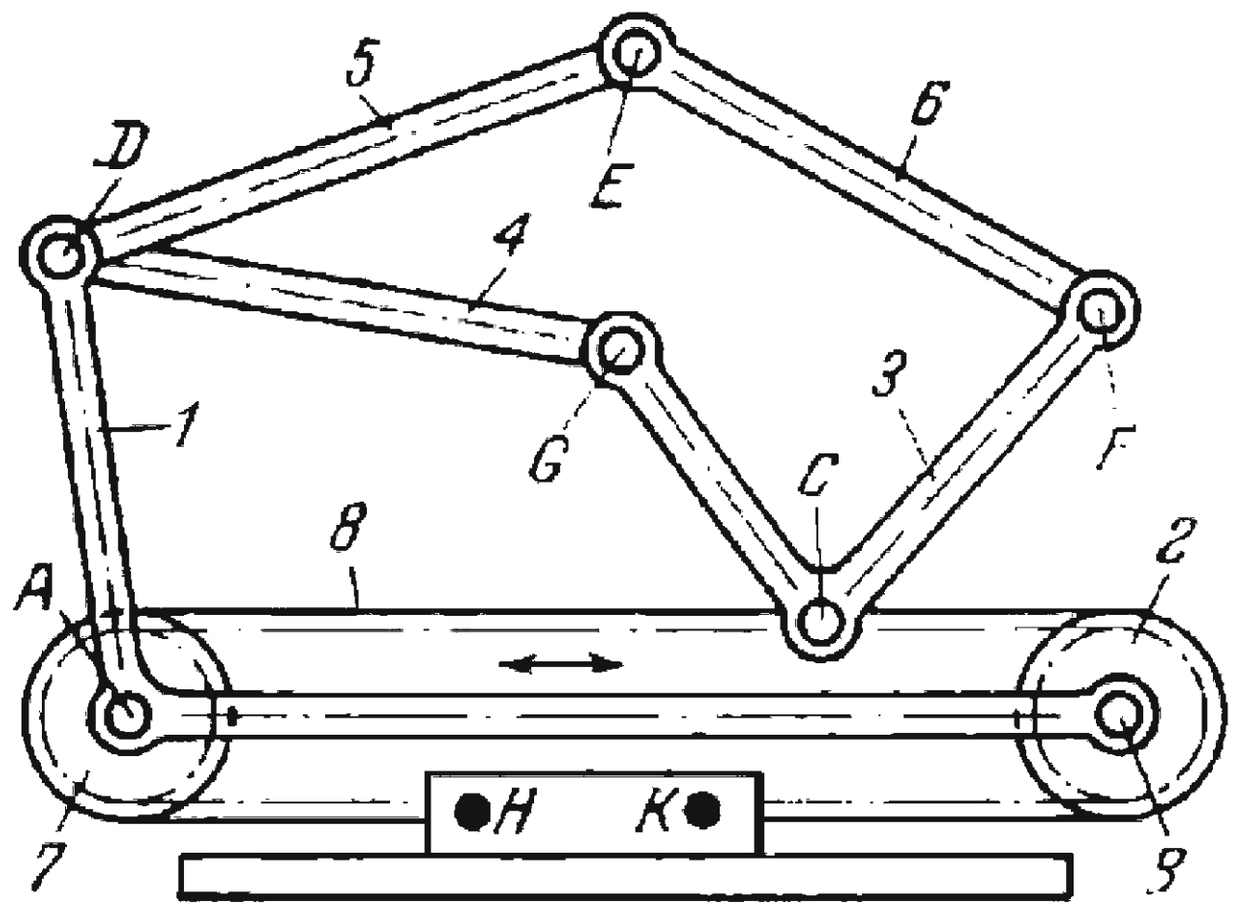
Link *1* is connected by turning pairs *A* and *B* to pulleys *2* and *6*, of equal diameter. Flexible link *5* runs over the pulleys and is rigidly secured at points *E* and *F* to the base. Links *3* and *4* are connected together by turning pair *D* and to flexible link *5* and to pulley *6* by turning pairs *C* and *B*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *5*, imparting complex motions to links *3* and *4*.

1960	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



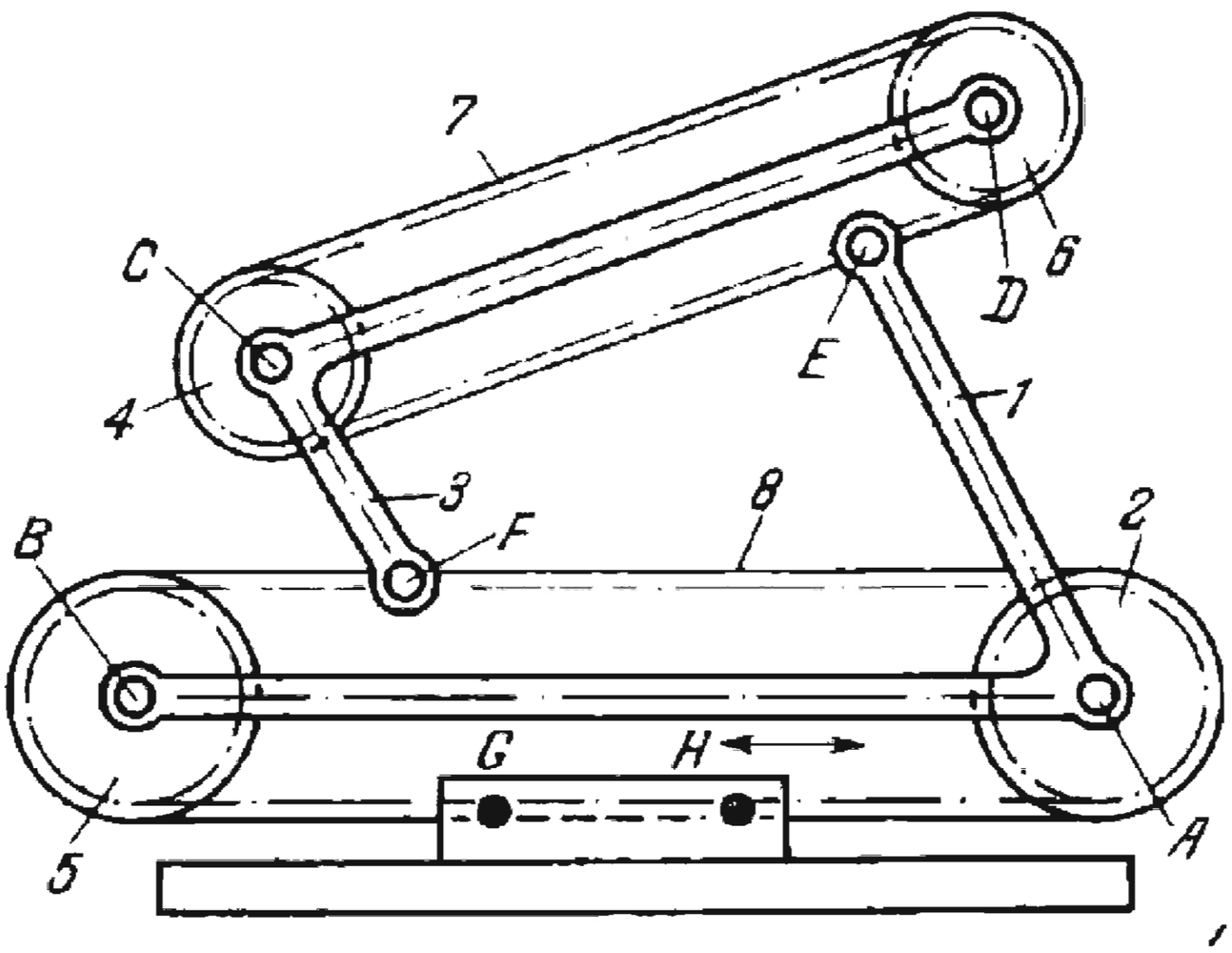
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *2* and *5*, of equal diameter. Flexible link *6* runs over the pulleys and is rigidly secured at points *G* and *F* to the base. Links *3* and *4* are connected together by turning pair *D* and to flexible link *6* and link *1* by turning pairs *C* and *E*. When link *1* has straight translational motion, pulleys *2* and *5* roll along flexible link *6*, imparting complex motions to links *3* and *4*.

1961	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



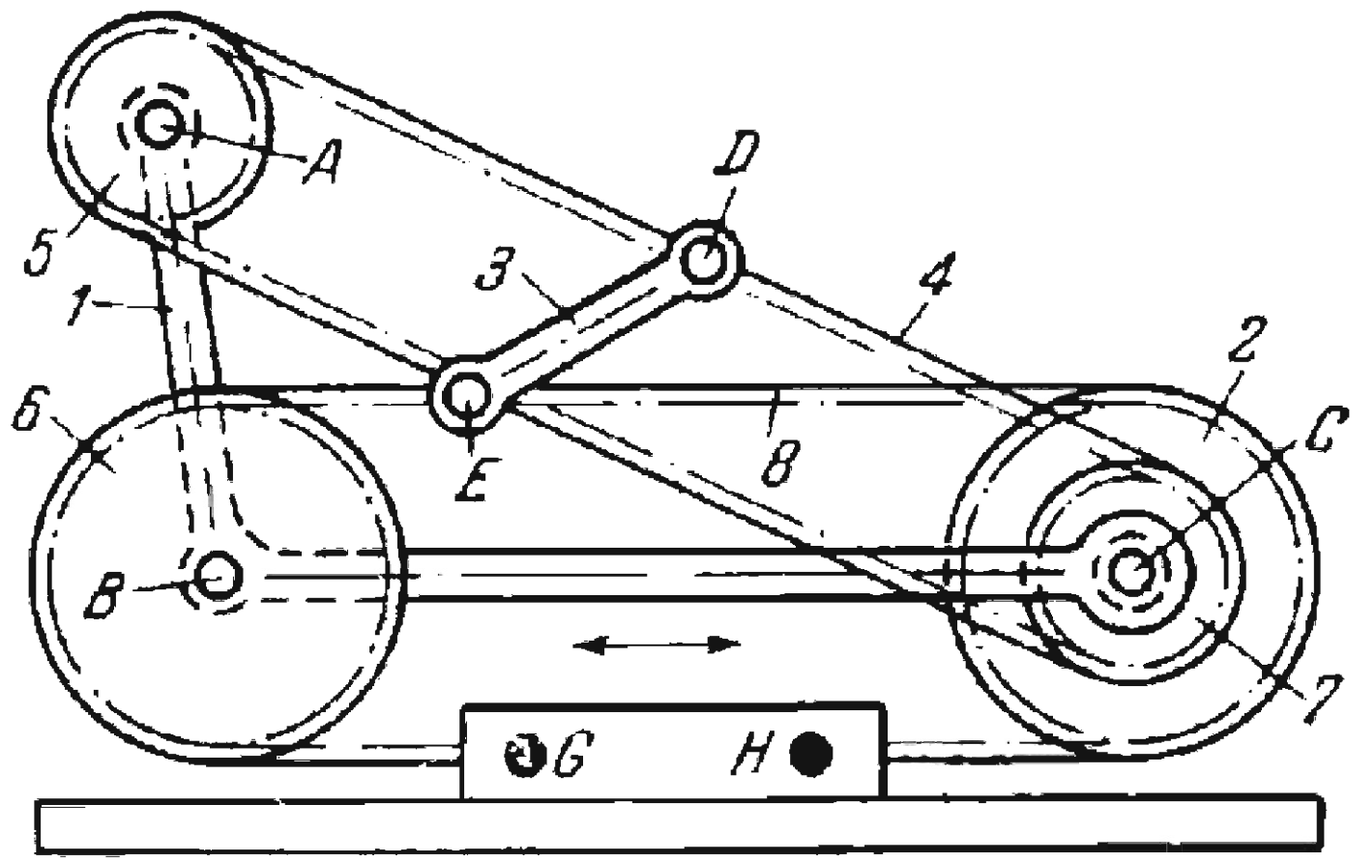
Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *7* and *2*, of equal diameter. Flexible link *8* runs over the pulleys and is rigidly secured at points *H* and *K* to the base. Link *3*, designed as a bent lever, is connected by turning pair *C* to flexible link *8* and by turning pairs *G* and *F* to links *4* and *6*. Link *5* is connected by turning pairs *D* and *E* to links *4* and *1* and to link *6*. When link *1* has straight translational motion, pulleys *2* and *7* roll along flexible link *8*, imparting complex motions to links *3*, *4*, *5* and *6*.

1962	HAIN LINKWORK CRAWLER MECHANISM	FL Cr

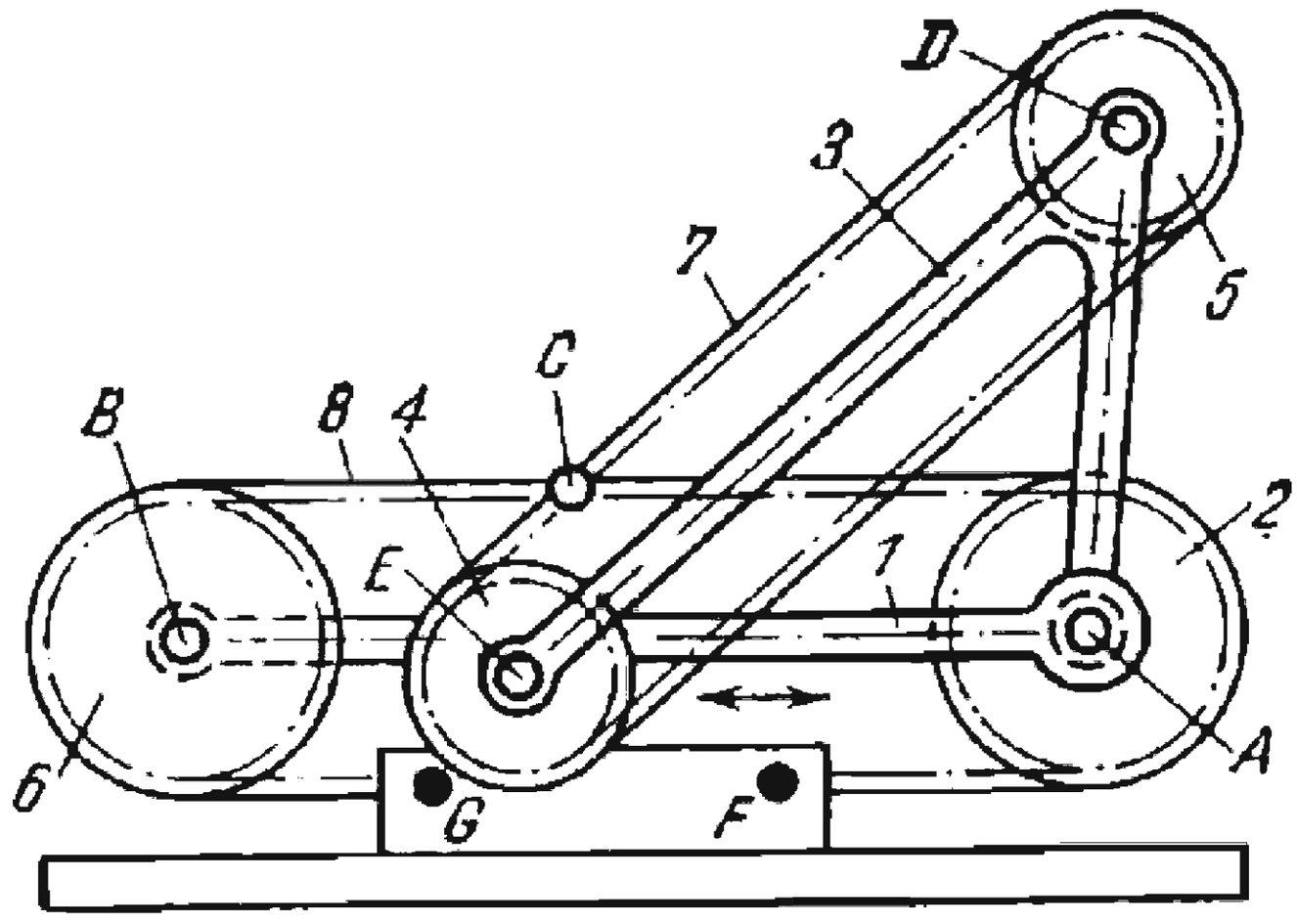


Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *6*. Link *1*, designed as a bent lever, is connected by turning pairs *A*, *B* and *E* to pulleys *2* and *5* and to flexible link *7* which runs over pulleys *4* and *6*. Link *3*, designed as a bent lever, is connected by turning pairs *C*, *D* and *F* to pulleys *4* and *6* and to flexible link *8* which runs over pulleys *2* and *5* and is rigidly secured at points *G* and *H* to the base. When link *1* has straight translational motion, pulleys *2* and *5* roll along flexible link *8* and pulleys *4* and *6* rotate about axes *C* and *D*, imparting complex motion to link *3*.

1963	HAIN LINKWORK CRAWLER MECHANISM	FL Cr

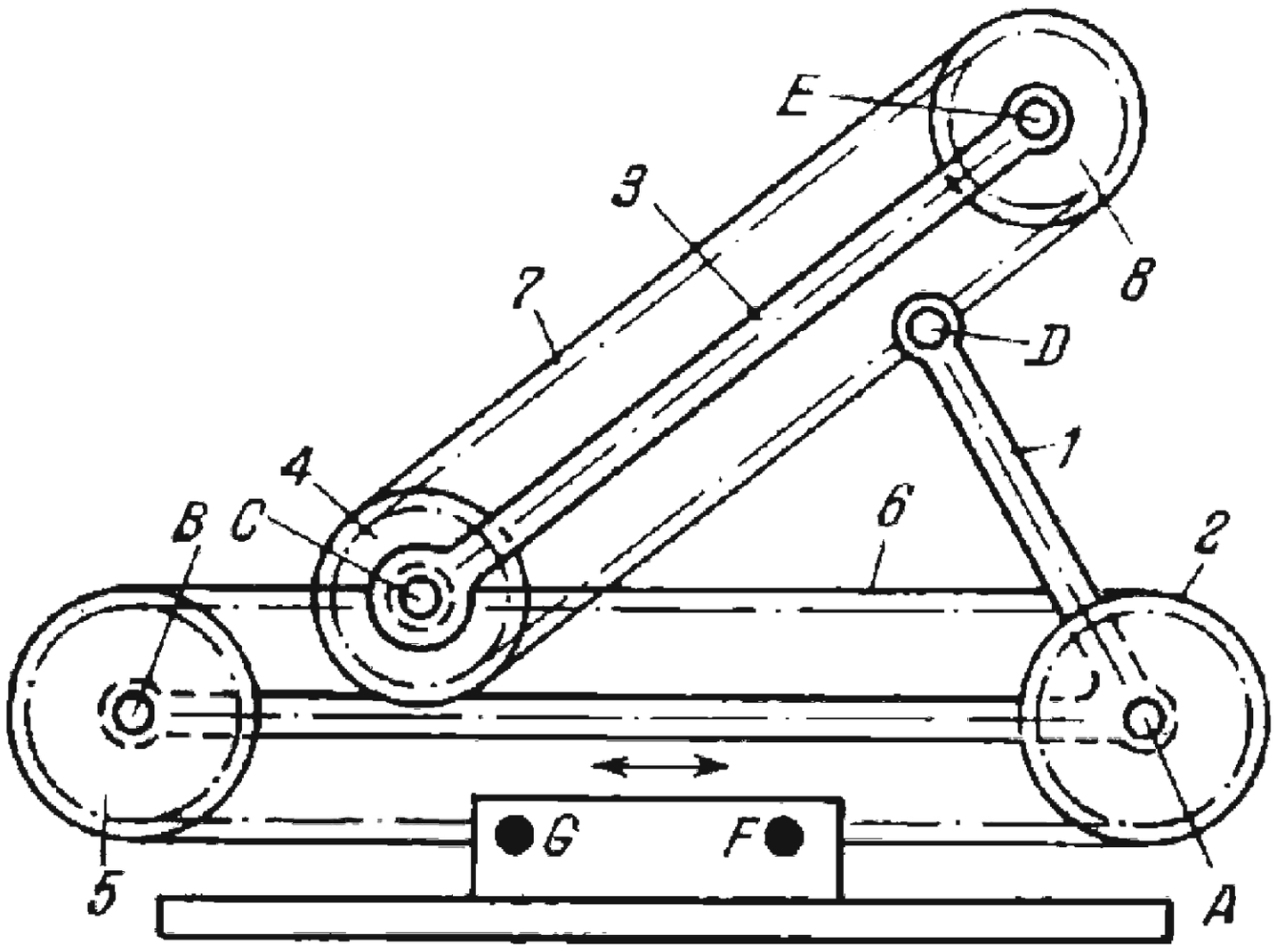


Pulleys *2* and *6* are of equal diameter, as are pulleys *5* and *7*. Link *1*, designed as a bent lever, is connected by turning pairs *A*, *B* and *C* to pulleys *5*, *6* and *2*. Flexible link *8* runs over pulleys *2* and *6* and is rigidly secured at points *G* and *H* to the base. Flexible link *4* runs over pulleys *5* and *7* which rotate about axes *A* and *C*. Link *3* is connected by turning pairs *D* and *E* to flexible links *4* and *8*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *8* and pulleys *5* and *7* rotate about axes *A* and *C*, imparting complex motion to link *3*.



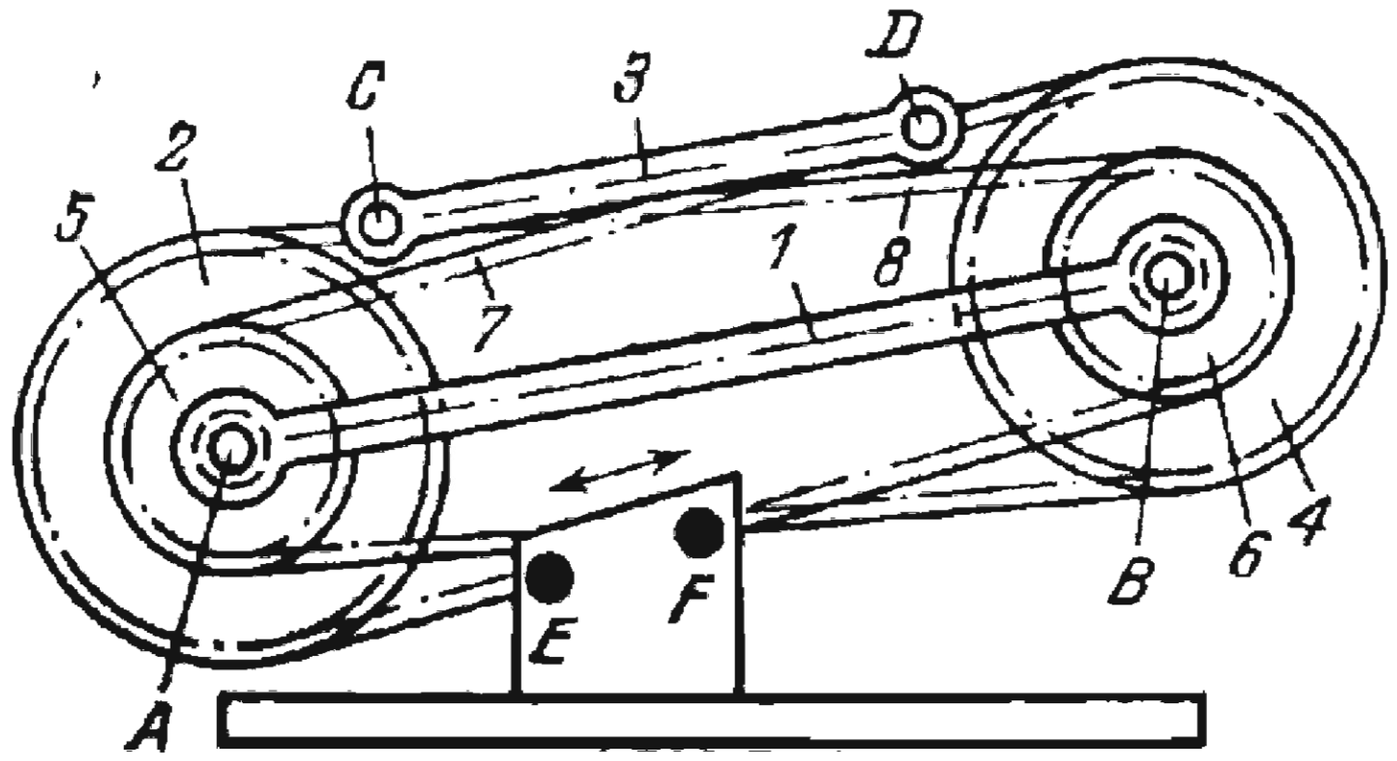
Pulleys *2* and *6* are of equal diameter, as are pulleys *4* and *5*. Link *1* is connected by turning pairs *A* and *B* to pulleys *2* and *6*. Flexible link *8* runs over pulleys *2* and *6* and is rigidly secured at points *G* and *F* to the base. Link *3*, designed as a bent lever, is connected by turning pairs *A*, *D* and *E* to pulleys *2*, *5* and *4*. Flexible link *7* runs over pulleys *4* and *5* and is connected by turning pair *C* to flexible link *8*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *8* and pulleys *4* and *5* rotate about axes *E* and *D*, imparting complex motion to link *3*.

1965	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



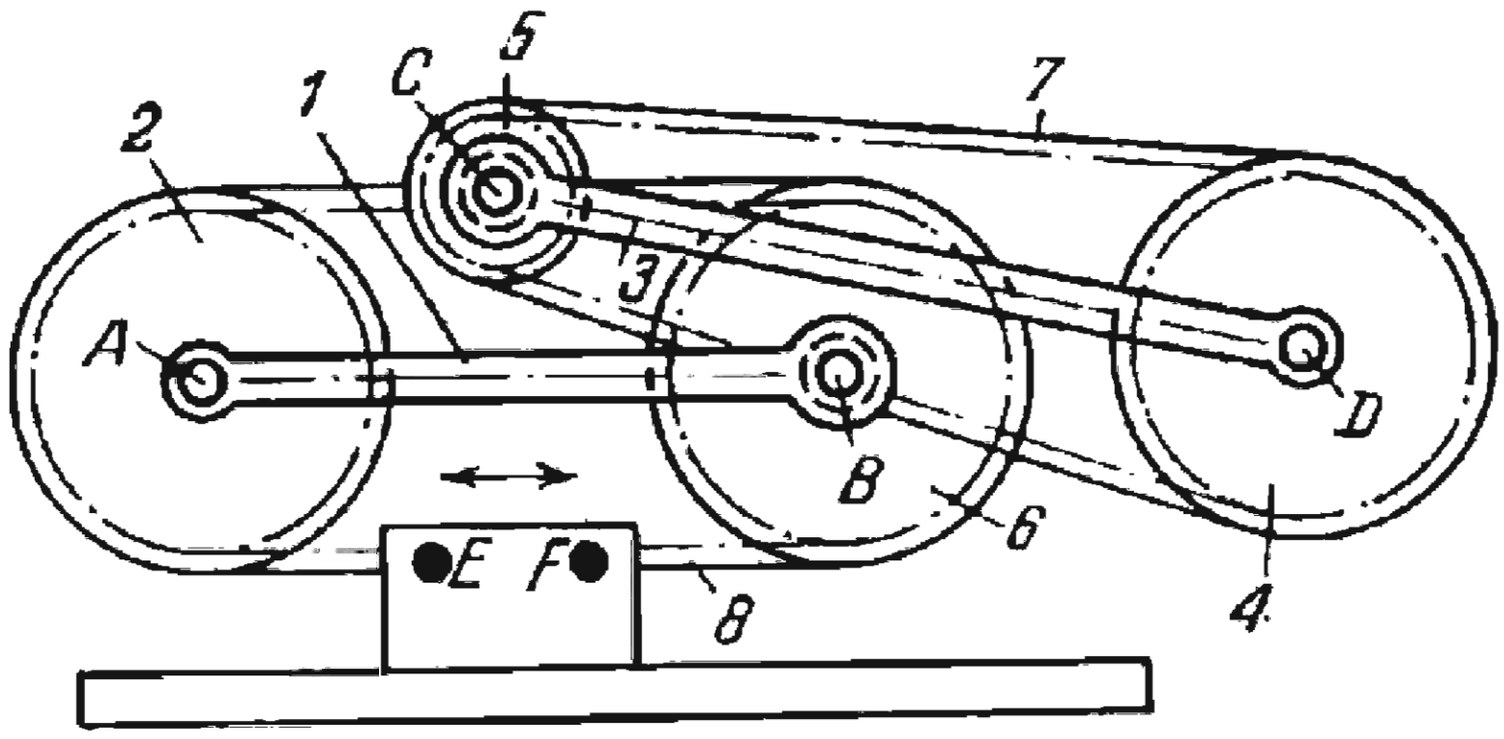
Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *8*. Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *2* and *5* and by turning pair *D* to flexible link *7* which runs over pulleys *4* and *8*. Flexible link *6* runs over pulleys *2* and *5* and is rigidly secured at points *G* and *F* to the base. Link *3* is connected by turning pairs *E* and *C* to pulleys *8* and *4*. Flexible link *6* is connected by turning pair *C* to pulley *4*. When link *1* has straight translational motion, pulleys *2* and *5* roll along flexible link *6* and pulleys *4* and *8* rotate about axes *C* and *E*, imparting complex motion to link *3*.

1966	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



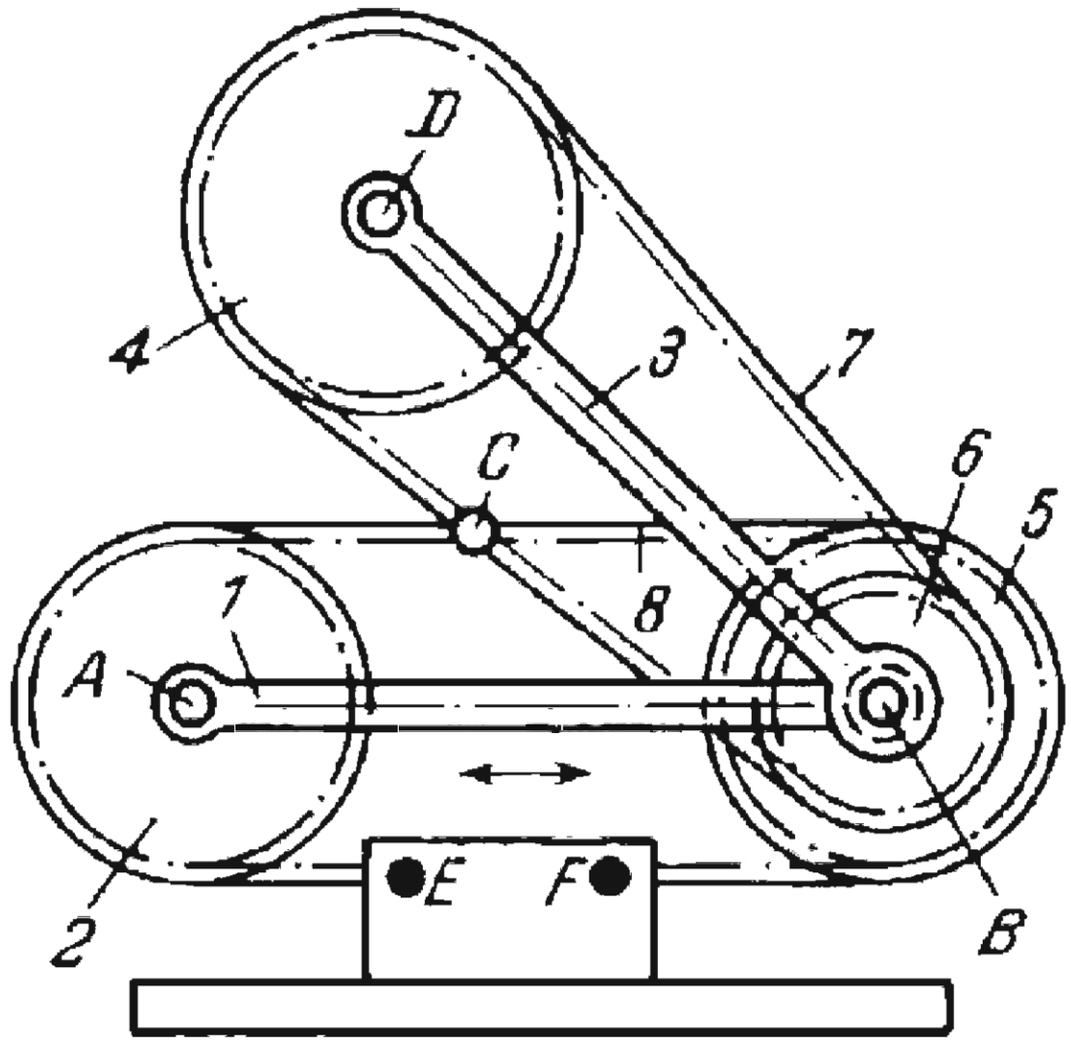
Pulleys *2* and *4* are of equal diameter, as are pulleys *5* and *6*. Link *1* is connected by turning pairs *A* and *B* to pulleys *2* and *6*. Flexible link *8* runs over pulleys *2* and *6* and is rigidly secured at points *E* and *F* to the base. Link *3* is connected by turning pairs *C* and *D* to flexible links *8* and *7*. Flexible link *7* runs over pulleys *4* and *5*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *8* and pulleys *4* and *5* rotate about axes *B* and *A*, imparting complex motion to link *3*.

1967	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



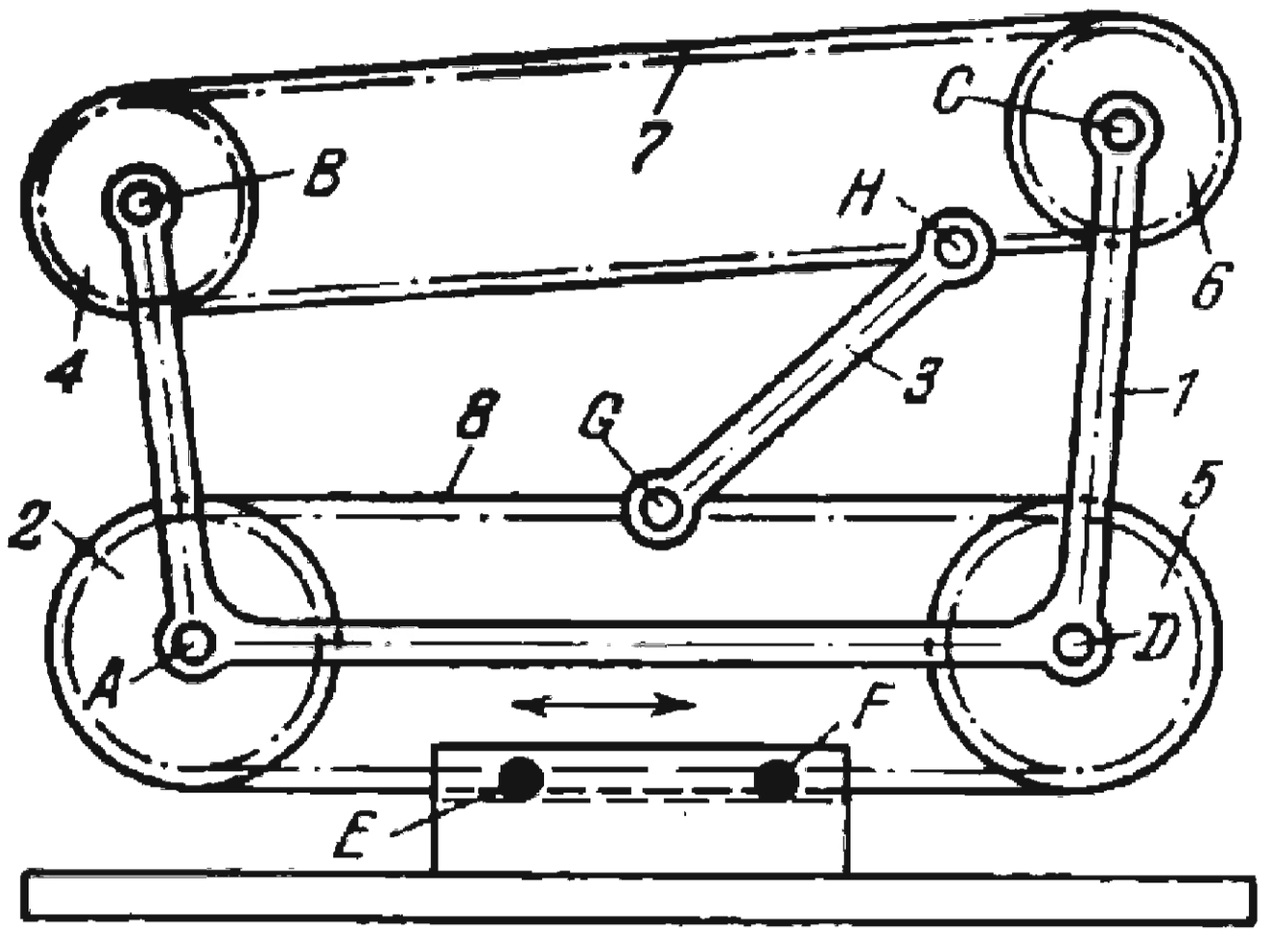
Pulleys *2*, *4* and *6* are of equal diameter. Link *1* is connected by turning pairs *A* and *B* to pulleys *2* and *6*. Flexible link *8* runs over pulleys *2* and *6* and is rigidly secured at points *E* and *F* to the base. Flexible link *8* is connected by turning pair *C* to pulley *5*. Link *3* is connected by turning pairs *C* and *D* to pulleys *5* and *4*. Flexible link *7* runs over pulleys *4* and *5* and is connected by turning pair *B* to link *1*. When link *1* has straight translational motion, pulleys *2* and *6* roll along flexible link *8* and pulleys *4* and *5* rotate about axes *D* and *C*, imparting complex motion to link *3*.

1968	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



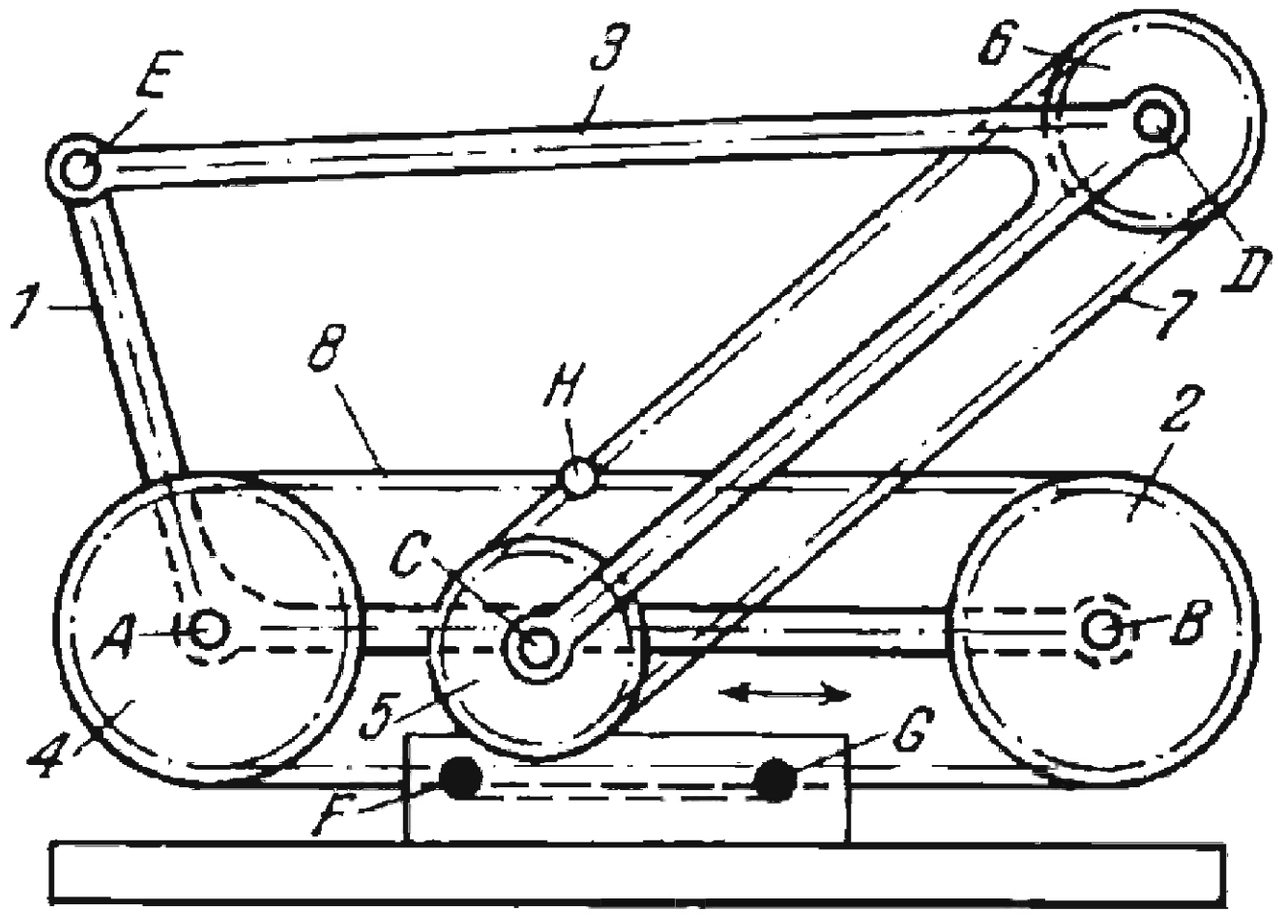
Link *1* is connected by turning pairs *A* and *B* to pulleys *2* and *5*, of equal diameter. Flexible link *8* runs over pulleys *2* and *5* and is rigidly secured at points *E* and *F* to the base. Flexible link *8* is connected by turning pair *C* to flexible link *7* which runs over pulleys *4* and *6*. Link *3* is connected by turning pairs *D* and *B* to pulleys *4* and *6*. When link *1* has straight translational motion, pulleys *2* and *5* roll along flexible link *8* and pulleys *4* and *6* rotate about axes *D* and *B*, imparting complex motion to link *3*.

1969	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



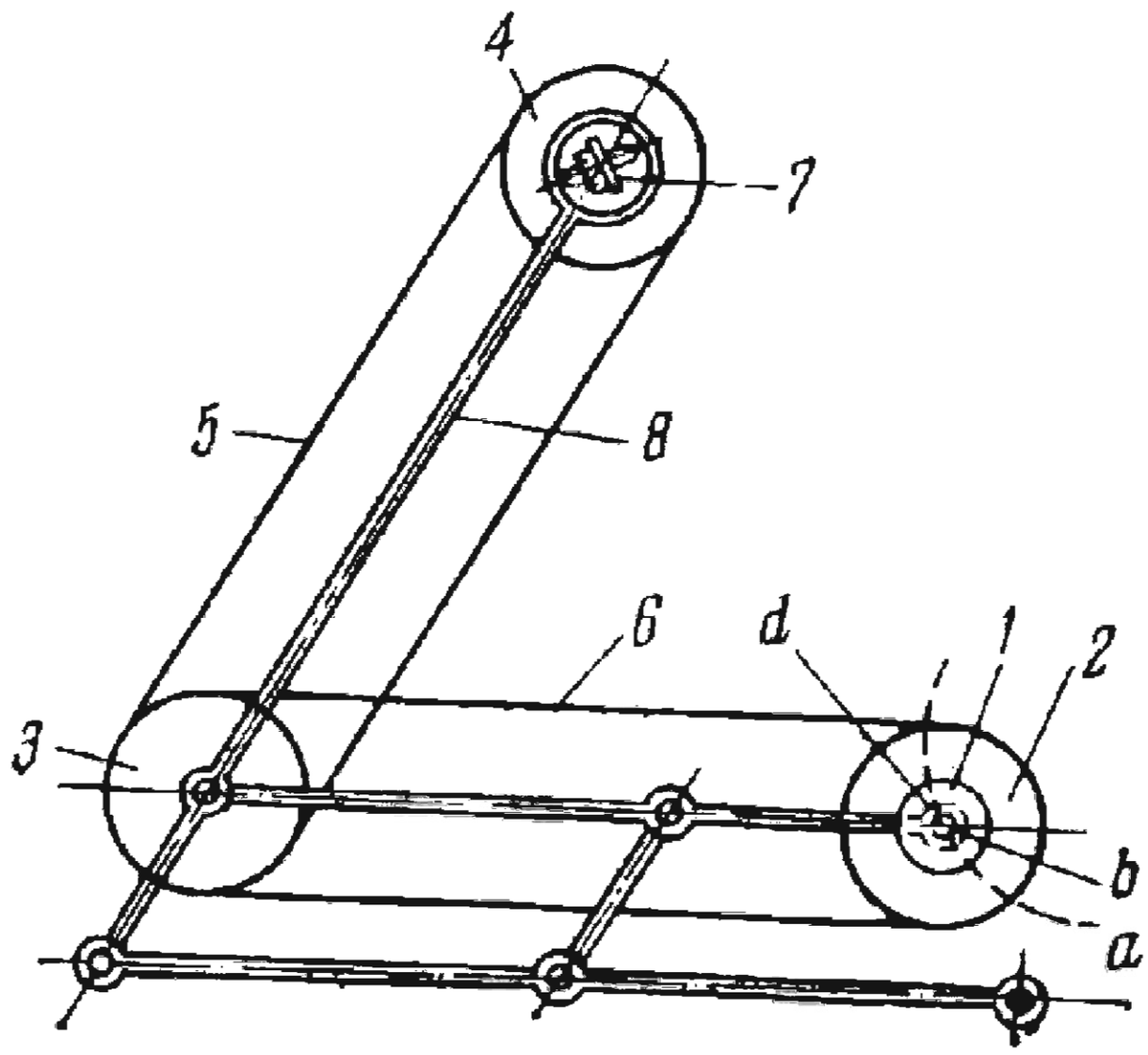
Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *6*. Link *1*, designed as a complex lever, is connected by turning pairs *A*, *B*, *C* and *D* to pulleys *2*, *4*, *6* and *5*. Flexible link *8* runs over pulleys *2* and *5* and is rigidly secured at points *E* and *F* to the base. Flexible link *7* runs over pulleys *4* and *6* which rotate about axes *B* and *C*. Link *3* is connected by turning pairs *G* and *H* to flexible links *8* and *7*. When link *1* has straight translational motion, pulleys *2* and *5* roll along flexible link *8* and pulleys *4* and *6* rotate about axes *B* and *C*, imparting complex motion to link *3*.

1970	HAIN LINKWORK CRAWLER MECHANISM	FL Cr



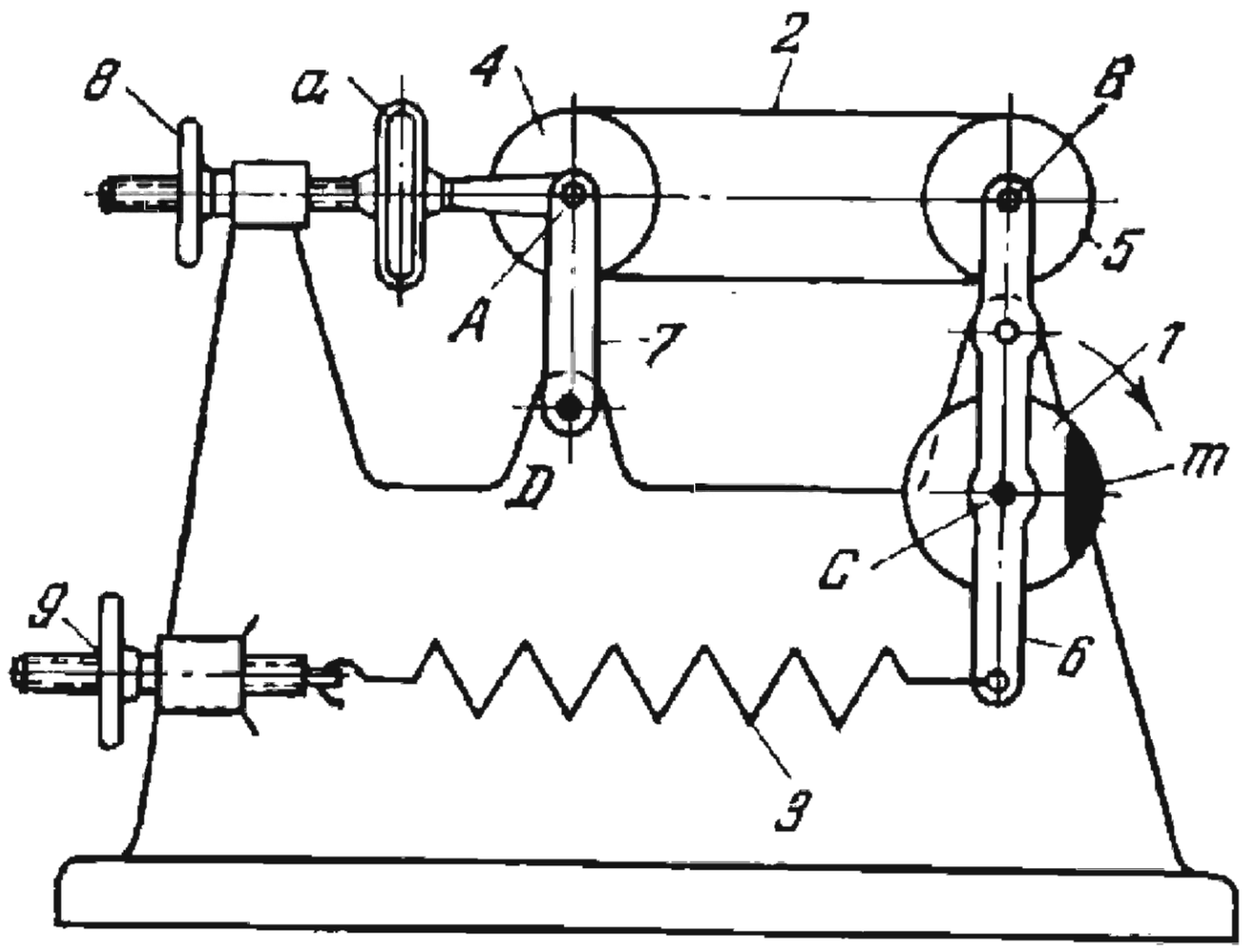
Pulleys *2* and *4* are of equal diameter, as are pulleys *5* and *6*. Link *1*, designed as a bent lever, is connected by turning pairs *A* and *B* to pulleys *4* and *2* and by turning pair *E* to link *3*. Link *3*, designed as a bent lever, is connected by turning pairs *D* and *C* to pulleys *6* and *5*. Flexible link *8* runs over pulleys *2* and *4* and is rigidly secured at points *F* and *G* to the base. Flexible link *7* runs over pulleys *5* and *6* and is connected by turning pair *H* to flexible link *8*. When link *1* has straight translational motion, pulleys *2* and *4* roll along flexible link *8* and pulleys *5* and *6* rotate about axes *C* and *D*, imparting complex motion to link *3*.

1971	LEVER-TYPE FLEXIBLE-LINK CURVIMETER MECHANISM	FL M



The field of view of magnifying glass *1*, located at the position of the tracing stylus of the pantograph, has two lines *d* and *b* perpendicular to each other. Curve *a* is traced with the intersection of the lines so that line *d* is always tangent to the curve and line *b* is along a normal to the curve. Cords *6* and *5*, running tightly over disks *2*, *3* and *4*, transmit rotation of magnifying glass *1* to recording wheel *7*, mounted on link *8* of the pantograph. As a result, recording wheel *7* rolls along the plane of the drawing so that the plane of the wheel is always parallel to line *d*. Therefore, the point of contact of wheel *7* with the plane of the drawing describes a curve similar to the given curve and recording wheel *7* measures the length of an arc of this curve.

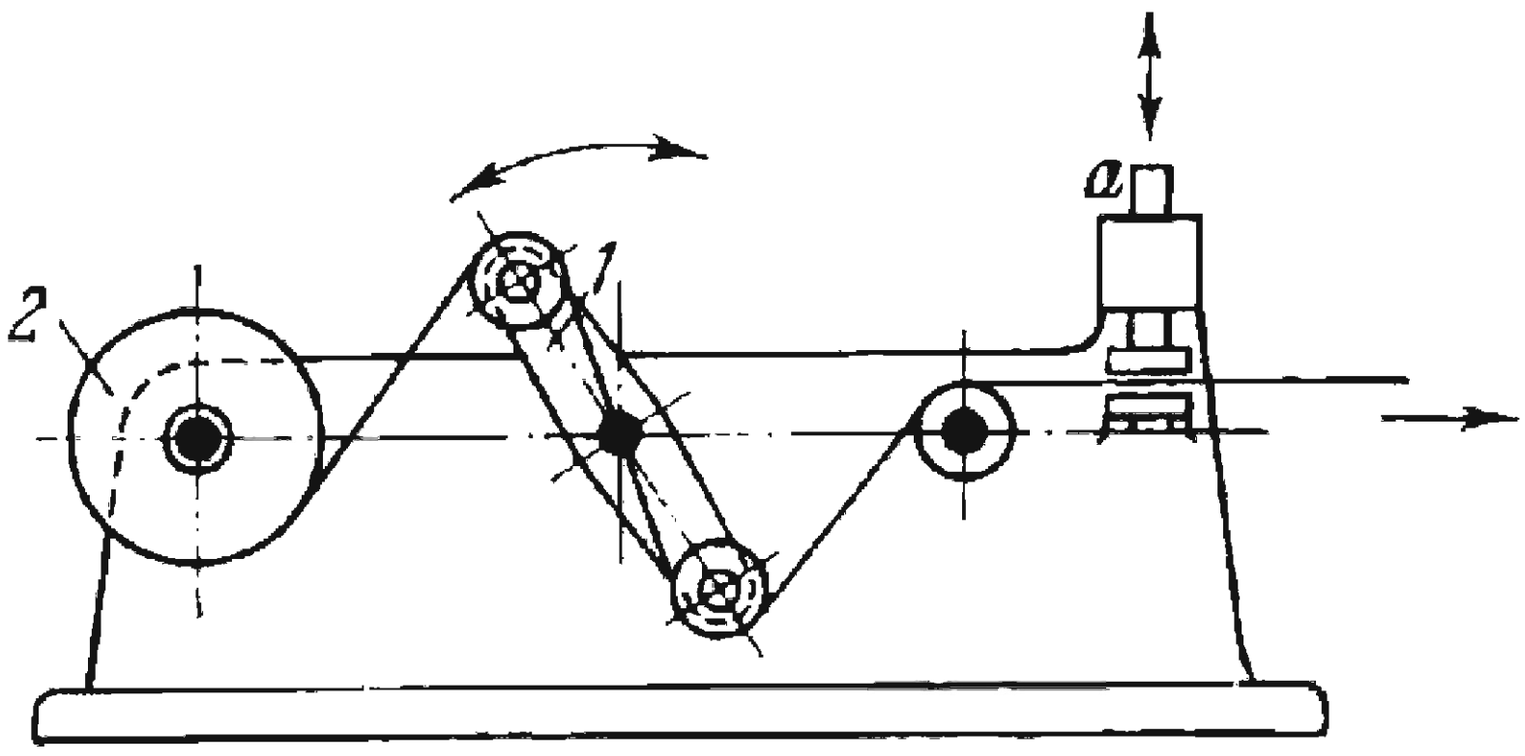
1972	LEVER-TYPE DEVICE FOR TESTING BELTS	FL M



Belt *2* runs over pulleys *4* and *5* which rotate about axes *A* and *B*. Links *6* and *7* turn about fixed axes *C* and *D*. Belt *2* is tensioned by screw device *8* with elastic element *a*. Disk *1* rotates about axis *C* of link *6*. Attached to disk *1* is unbalanced mass *m*. When disk *1* rotates, belt *2* being tested is subjected to a pulsating load due to the action of unbalanced mass *m* and spring *3*. Screw device *9* regulates the tension of spring *3*.

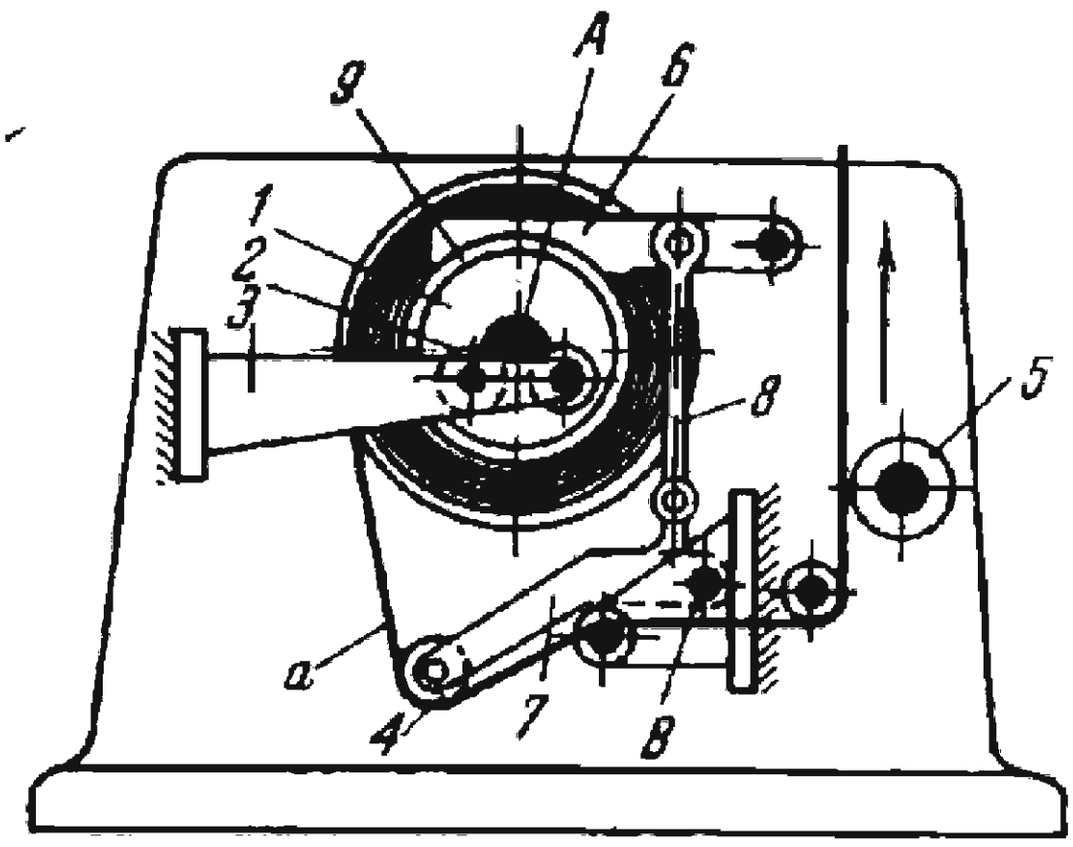
8. SORTING AND FEEDING MECHANISMS (1973 and 1974)

1973	LEVER-TYPE PAPER TAPE FEED DEVICE	FL SF



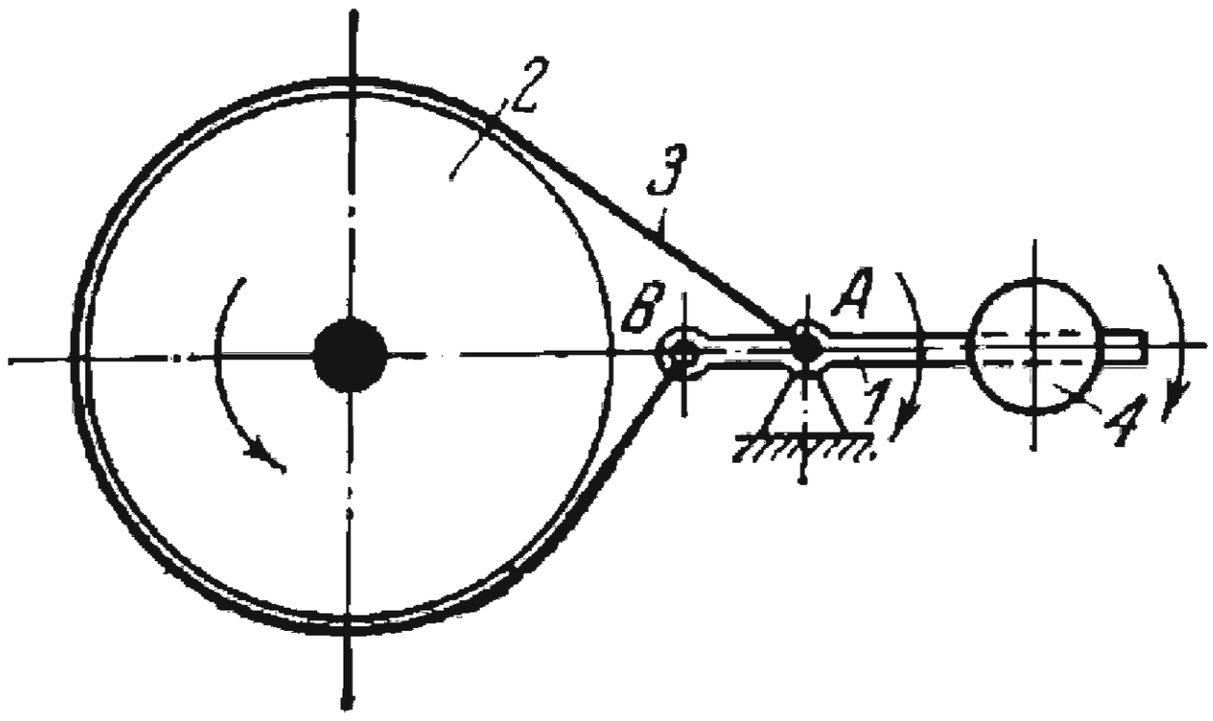
Two-arm lever *1* pulls paper tape off reel *2*. The free end of the tape is gripped by clamp *a*. When tape is being used to pack a parcel, clamp *a* is released and lever *1* returns to its initial position.

1974	LEVER-TYPE PAPER STRIP FEED DEVICE	FL SF



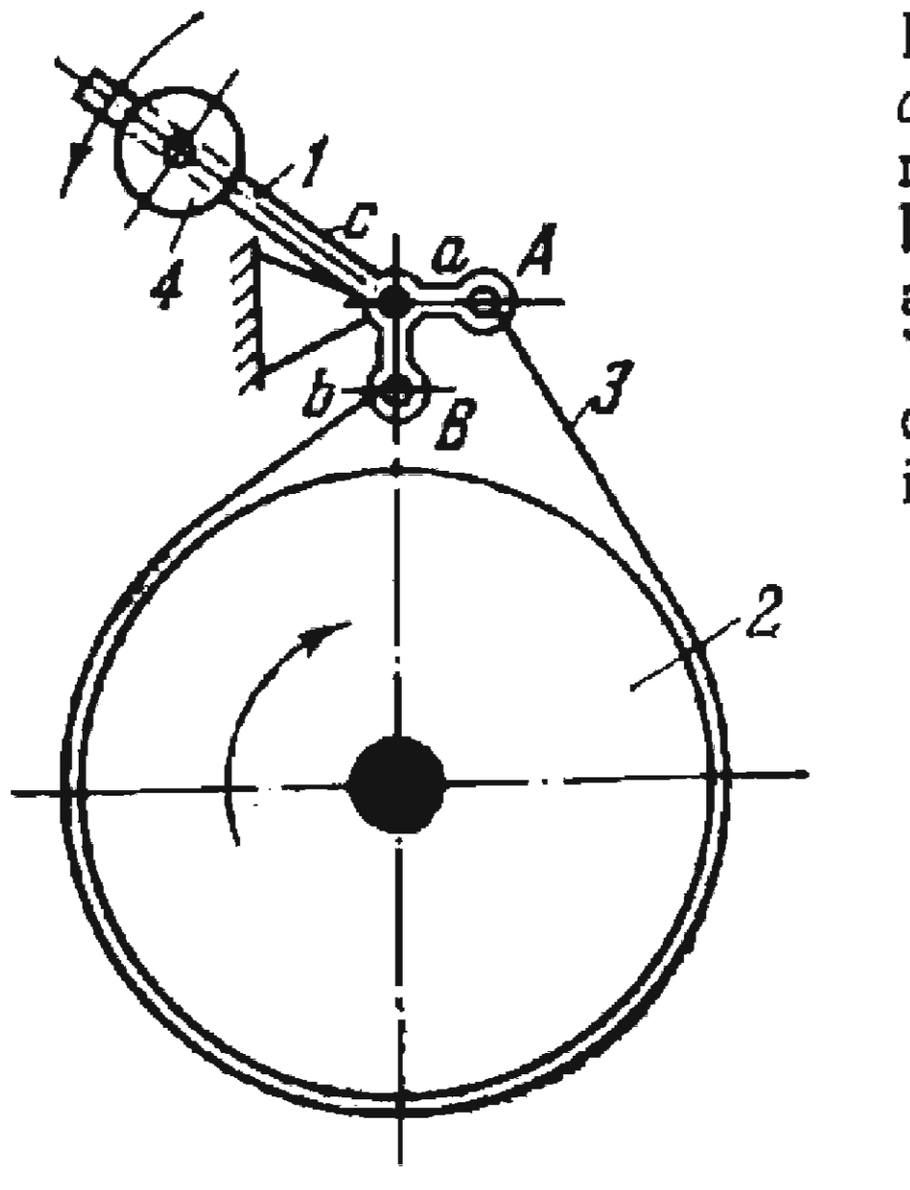
Shaft *A* of paper reel *1* is supported by rollers *2* mounted on brackets *3*. Paper strip *a* runs over roll *4* and passes guide rolls to printing roller *5*. Roll *4* is mounted on frame *7* which turns about fixed axis *B* secured between the side-walls of the device. Due to the weight of frame *7*, paper strip *a* is unwound from reel *1*. As the strip unwinds, roll *4* descends and frame *7* lowers brake shoe *6*, connected to the frame by tie-rod *8*. When the tension of the paper strip increases, roll *4* is raised slightly, decreasing the friction between shoe *6* and brake disk *9* so that some more paper is unwound from the reel.

1975	LEVER-TYPE MECHANISM OF A BAND BRAKE	FL Br



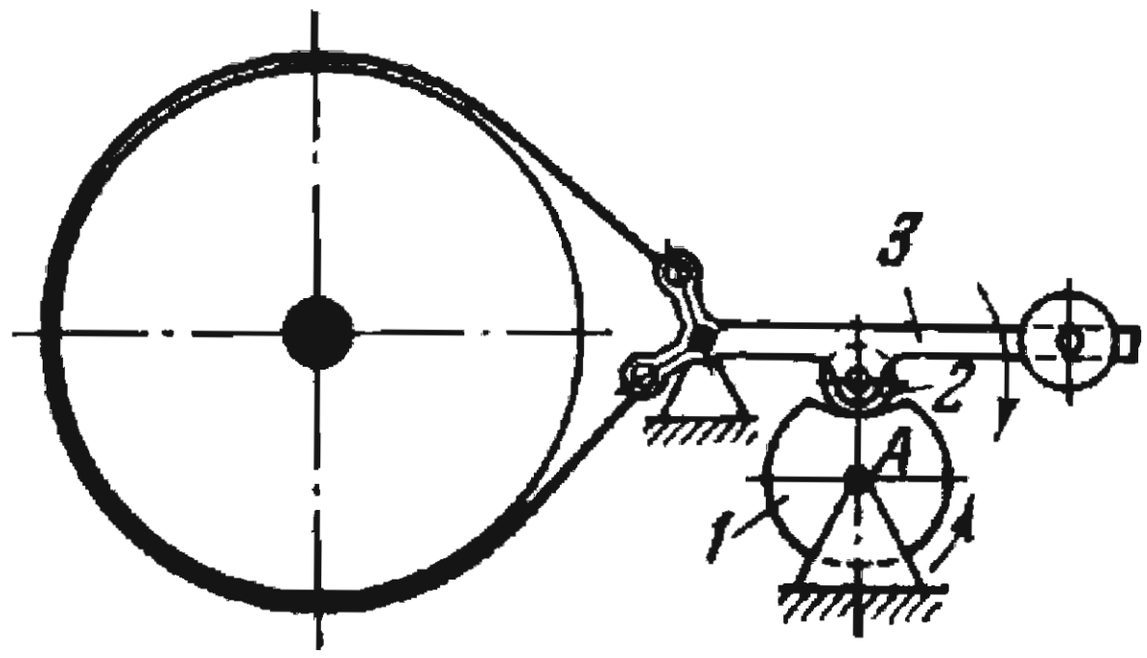
Brake band *3* is pivoted at point *A*, on the axis of revolution of lever *1*, and at point *B* of lever *1*. Weight *4* can be shifted and clamped along the axis of lever *1*. Drum *2* is braked by turning lever *1* clockwise about fixed axis *A*.

1976	LEVER-TYPE MECHANISM OF A BAND BRAKE	FL Br



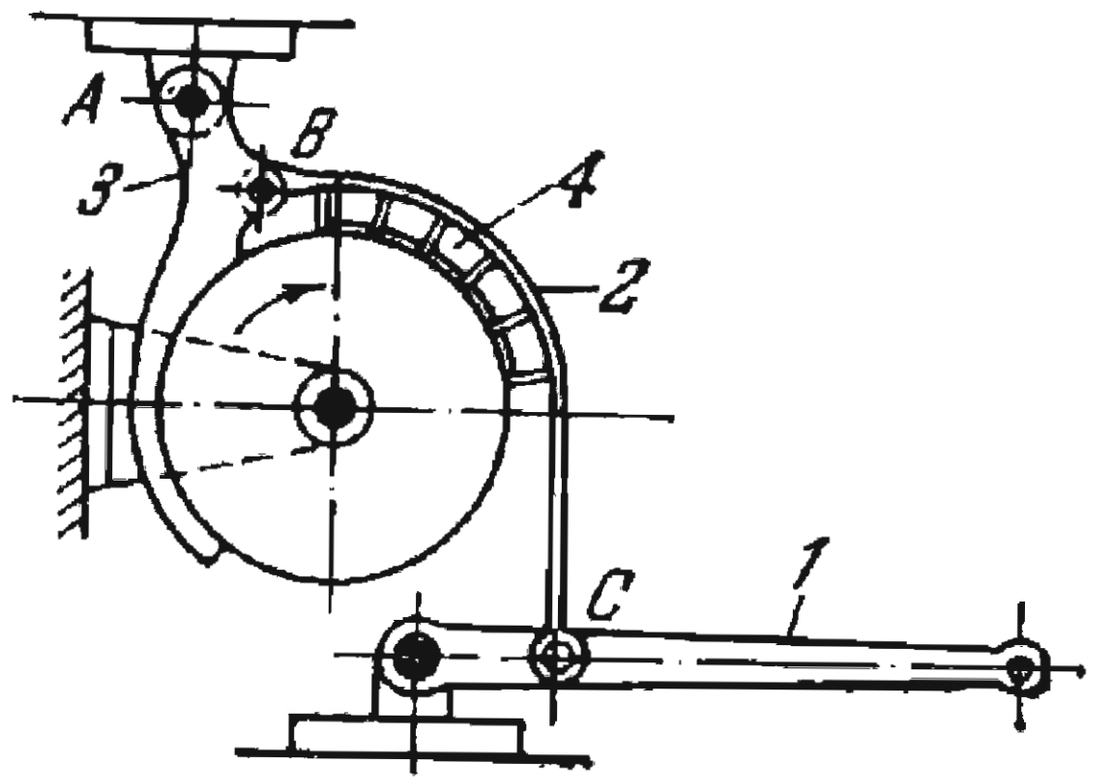
Lever *1* has two extensions, *a* and *b*, symmetrical with respect to handle *c*. Brake band *3* is pivoted at points *A* and *B* to extensions *a* and *b*. Weight *4* can be shifted and clamped along handle *c*. Drum *2* is braked by turning lever *1* counterclockwise.

1977	LEVER-TYPE MECHANISM OF A BAND BRAKE WITH A RELEASING DEVICE	F	FL Br



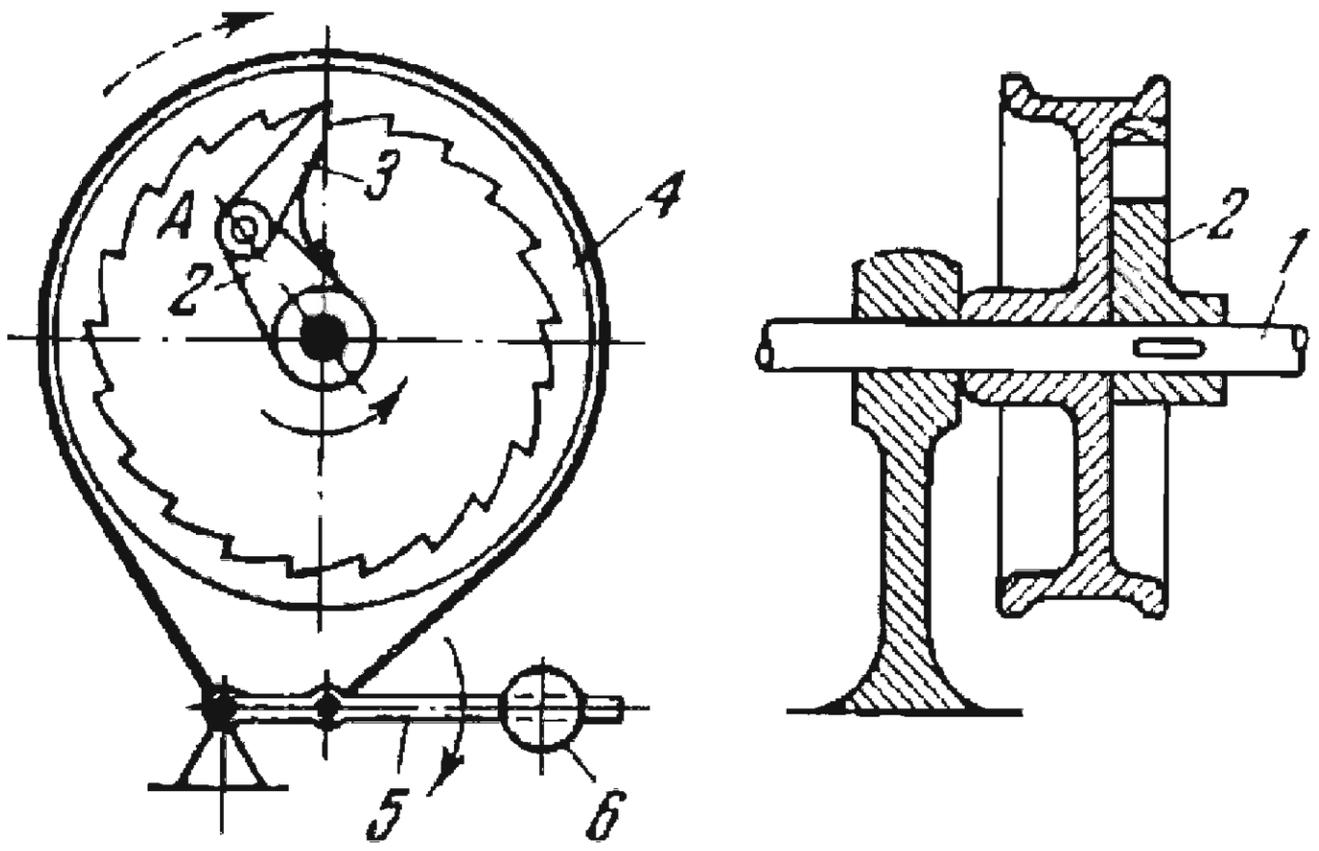
Lever *3* has roller *2* which enters a slot in disk *1* when the brake is applied. Disk *1* rotates about fixed axis *A*. The brake is released by turning disk *1* to raise lever *3*.

1978	LEVER-TYPE MECHANISM OF A BAND BRAKE WITH A RIGID SHOE	FL Br



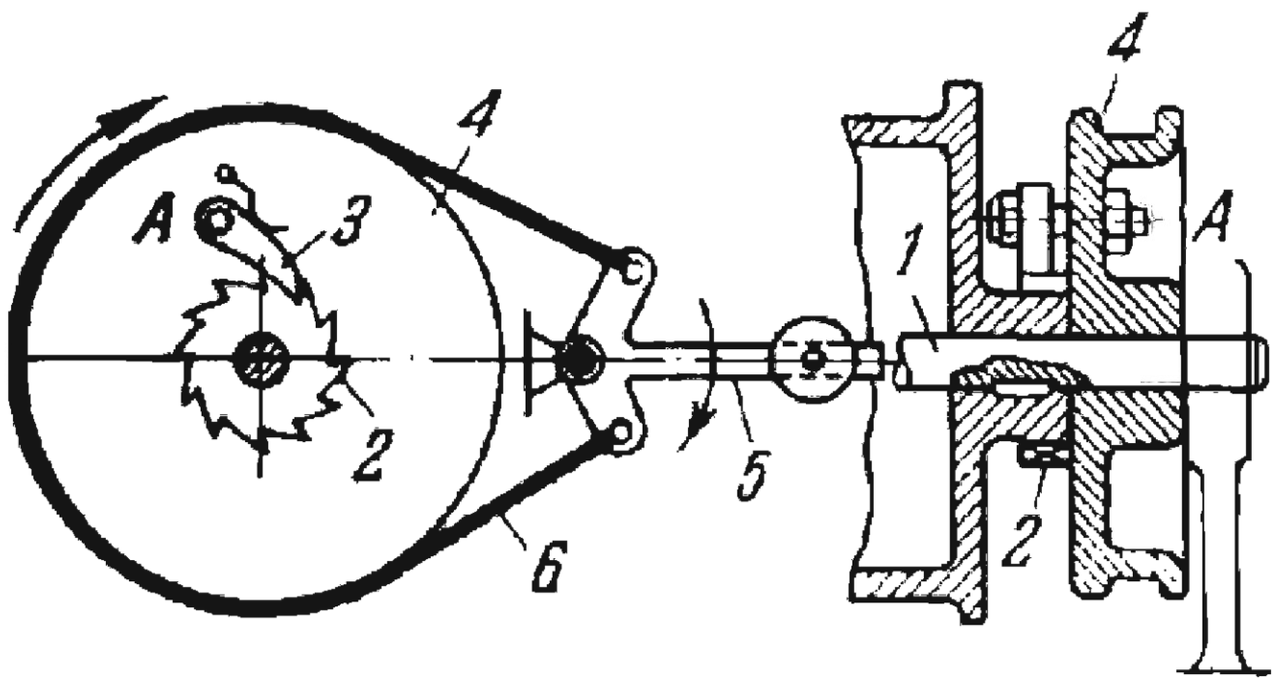
The brake has rigid shoe *3* which turns about fixed axis *A*. One end of band *2* is pivoted to shoe *3* at point *B*. The other end is pivoted at point *C* to lever *1*. Band *2* has flexible lining *4*. When lever *1* is turned clockwise, band *2* is tensioned and shoe *3* and lining *4* are pressed against the brake drum.

1979	LEVER-TYPE MECHANISM OF A BAND BRAKE WITH RATCHET GEARING	FL Br



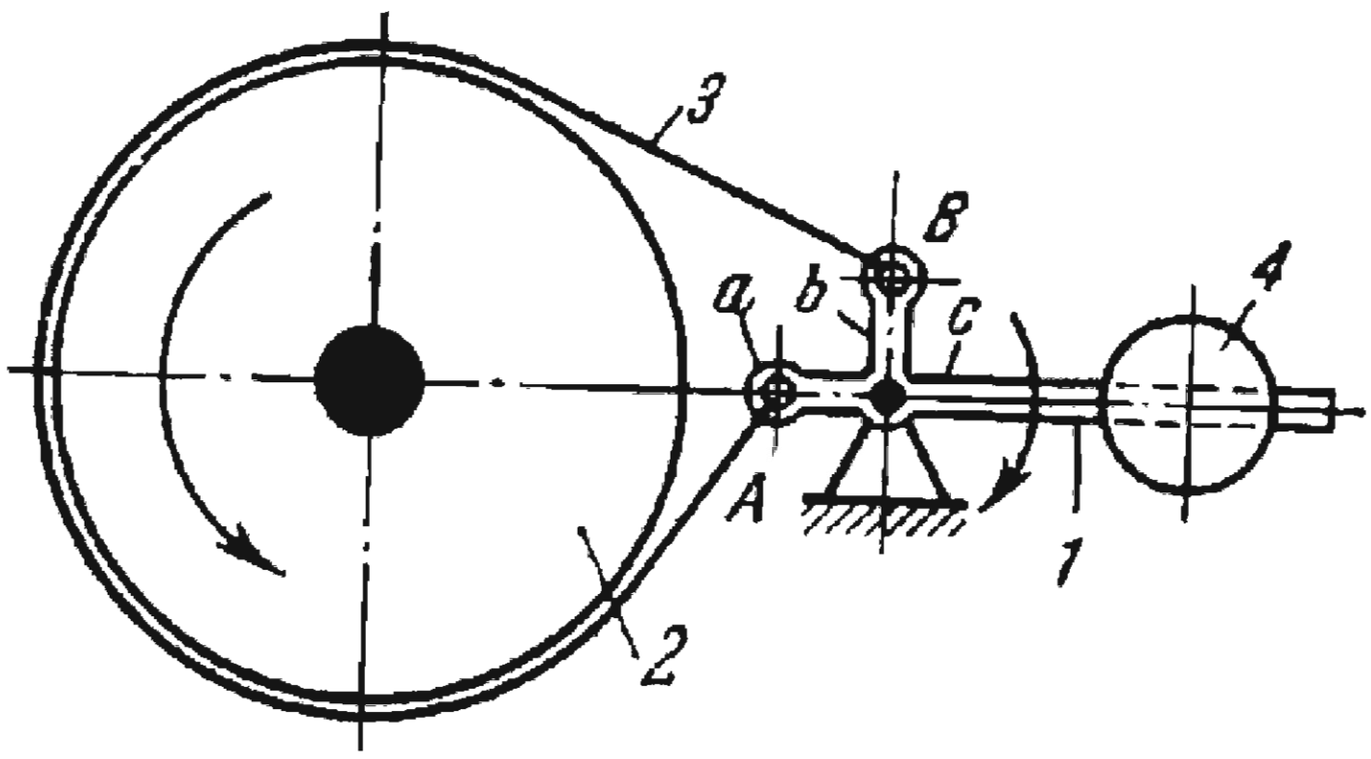
Crank *2* is keyed on shaft *1* and is connected by turning pair *A* to pawl *3* which engages the internal ratchet teeth of brake drum *4*. When shaft *1* rotates counterclockwise, the pawl slides over the ratchet teeth. If shaft *1* begins to rotate clockwise, it is braked by a steel band running over drum *4* and tensioned by lever *5* and weight *6*.

1980	LEVER-TYPE MECHANISM OF A BAND BRAKE WITH RATCHET GEARING	FL Br



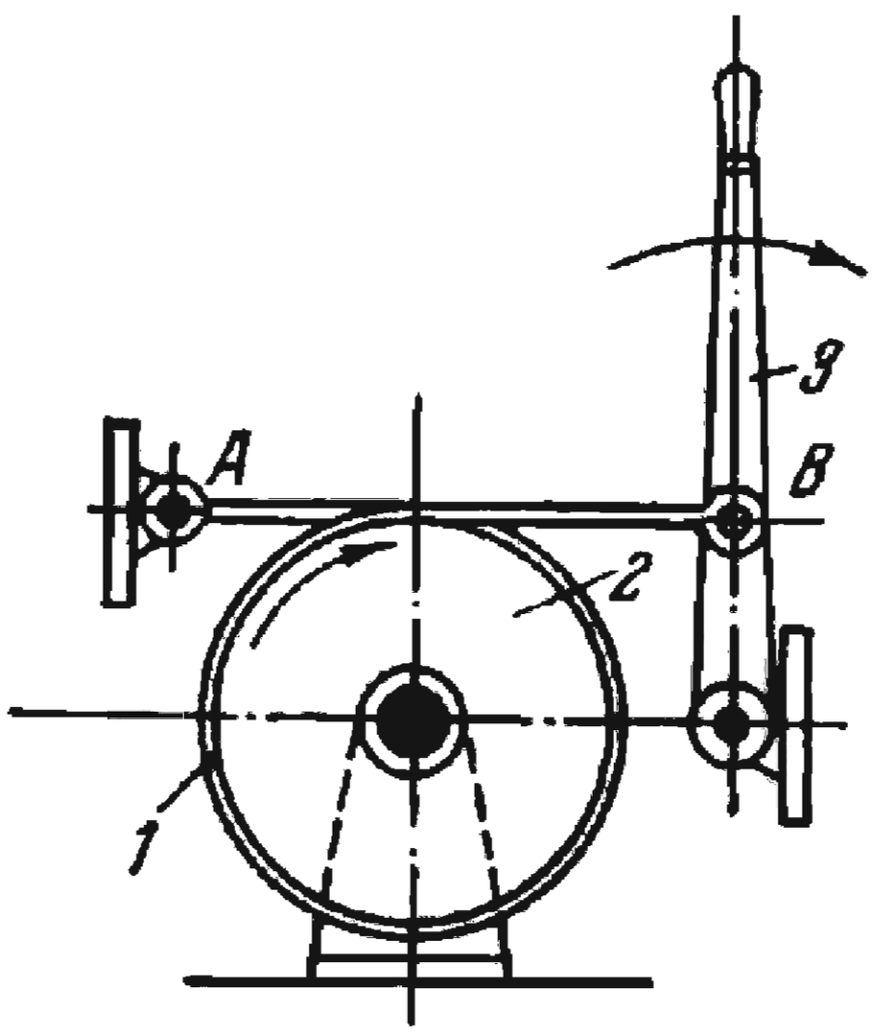
Keyed on shaft *1* is ratchet wheel *2* which engages pawl *3*. Pawl *3* turns about axis *A* of drum *4*. Shaft *1* can rotate freely clockwise because pawl *3* slides over the ratchet teeth. If shaft *1* begins to rotate counterclockwise, it is braked by band *6* running over drum *4* and having its ends pivoted to lever *5*.

1981	LEVER-TYPE MECHANISM OF A BAND BRAKE	FL Br



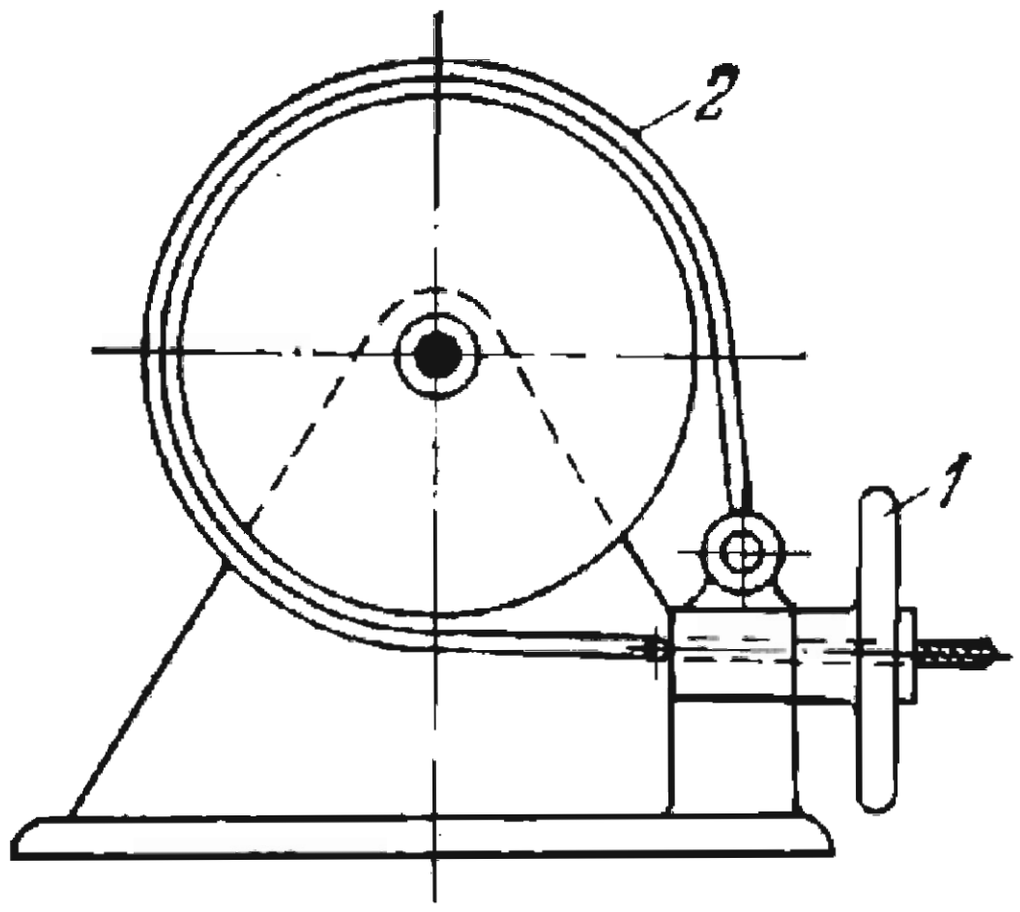
Lever *1* has two extensions, *a* and *b*, and handle *c*. Brake band *3* is pivoted at points *A* and *B* to extensions *a* and *b*. The arrangement of extensions *a* and *b* enables drum *2* to be gradually and smoothly braked. Weight *4* can be shifted and clamped along handle *c*. The brake is applied by turning lever *1* clockwise.

1982	LEVER-TYPE MECHANISM OF A BAND BRAKE	FL Br



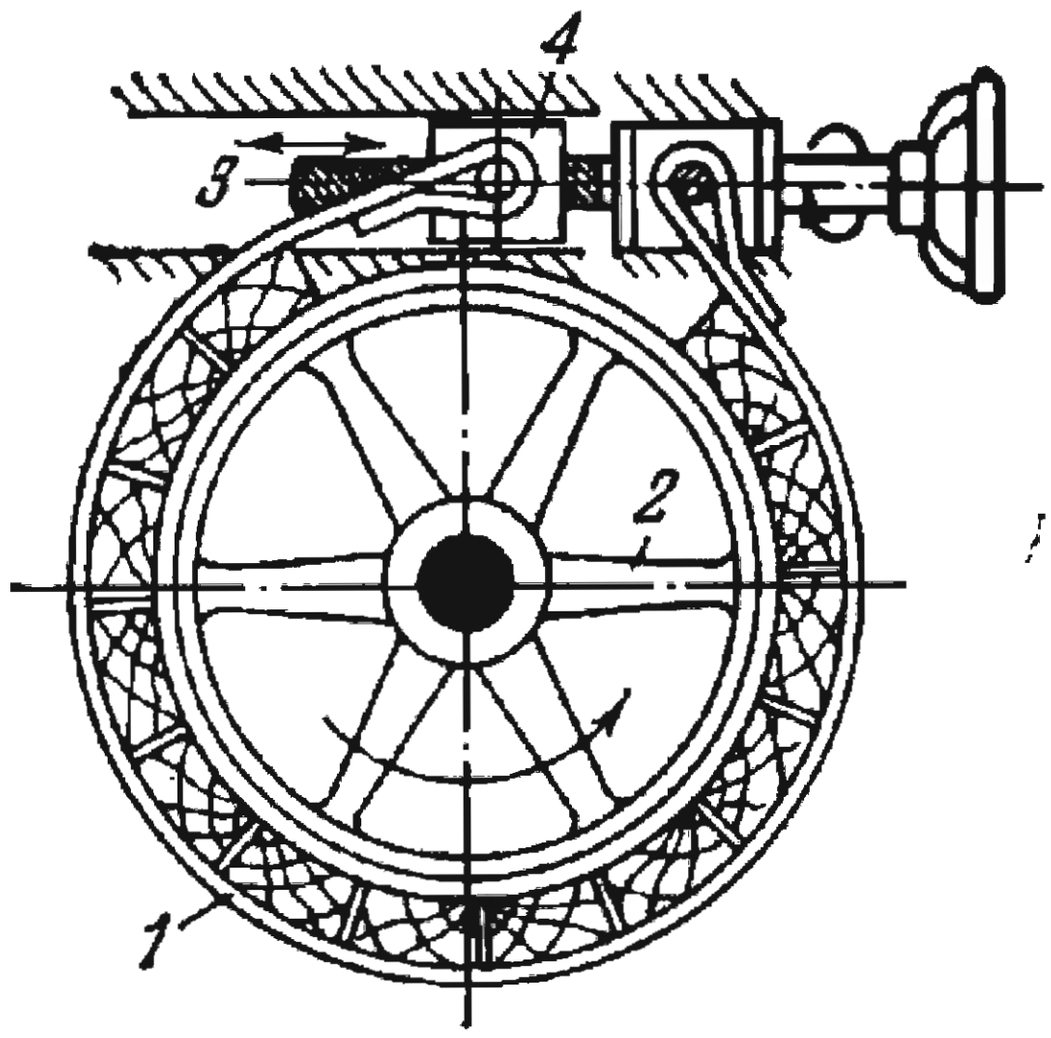
One end of brake band *1* is pivoted at point *A*. The band runs around drum *2* through an angle of 360° and its other end is pivoted at point *B* to lever *3*. The brake is applied by turning lever *3* clockwise.

1983	SCREW-TYPE MECHANISM OF A BAND BRAKE	FL Br



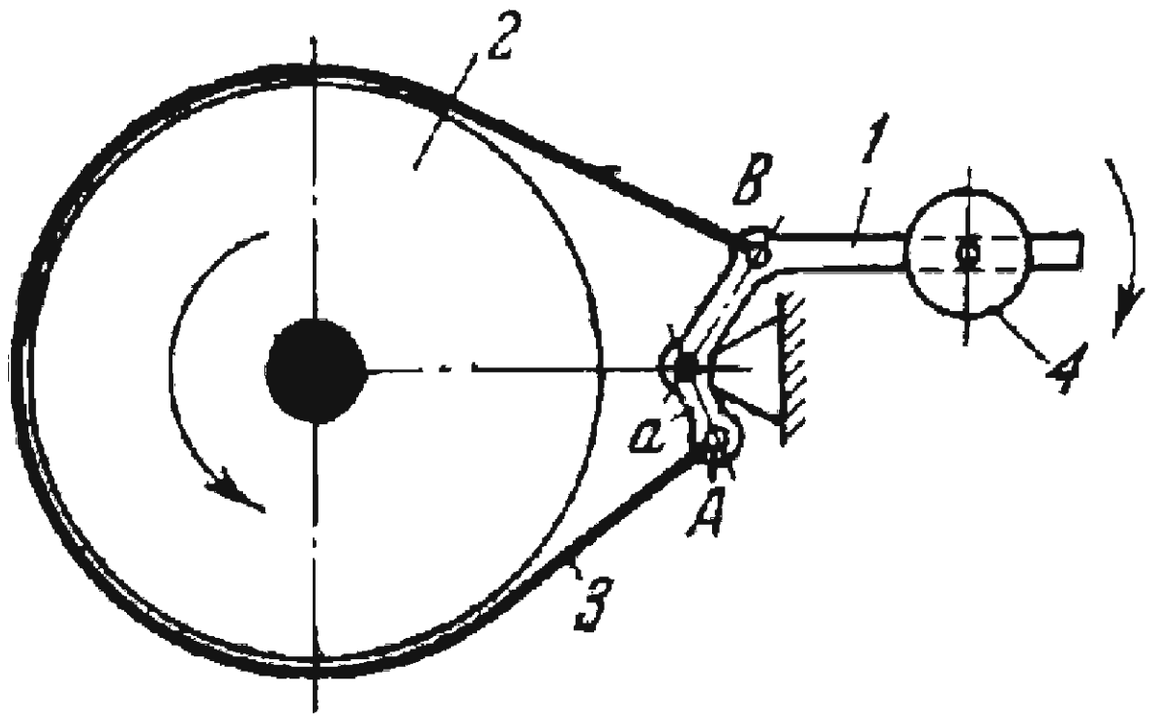
When handwheel *1* is turned, brake band *2* is tensioned and the drum (or pulley) is braked.

1984	SCREW-TYPE MECHANISM OF A BAND BRAKE	FL Br



Brake band *1* with its wooden cleats is pressed against brake drum *2* by means of screw *3* and nut *4* which slides along guides and brings the ends of the band closer together.

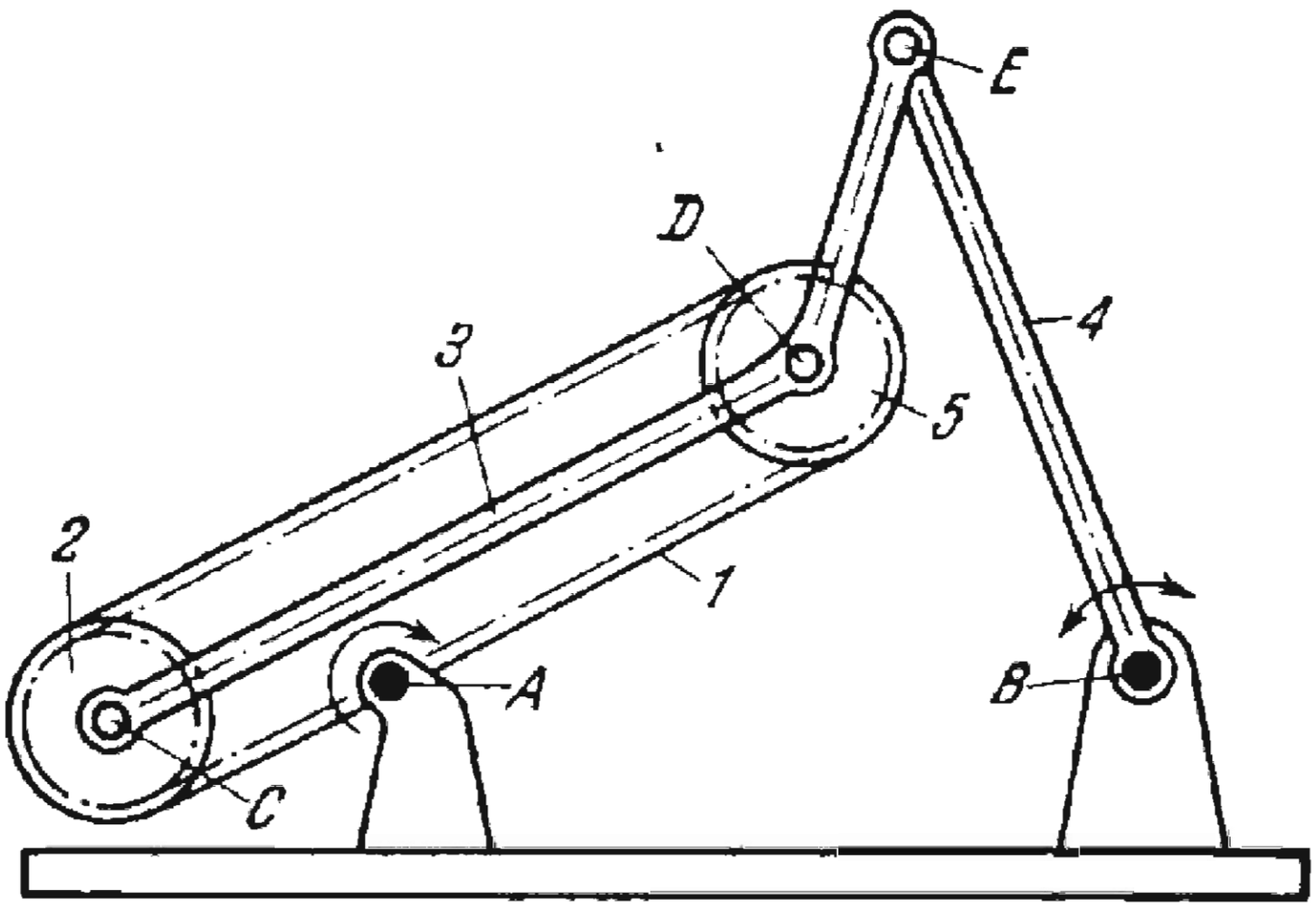
1985	LEVER-TYPE MECHANISM OF A SMOOTH-ACTION BAND BRAKE	FL Br



Lever *1* **has extension** *a*. **Brake band** *3* **is pivoted at point** *B* **to lever** *1* **and at point** *A* **to extension** *a*. **Weight** *4* **can be shifted and clamped along the axis of lever** *1*. **The brake is applied to drum** *2* **by turning lever** *1* **clockwise.**

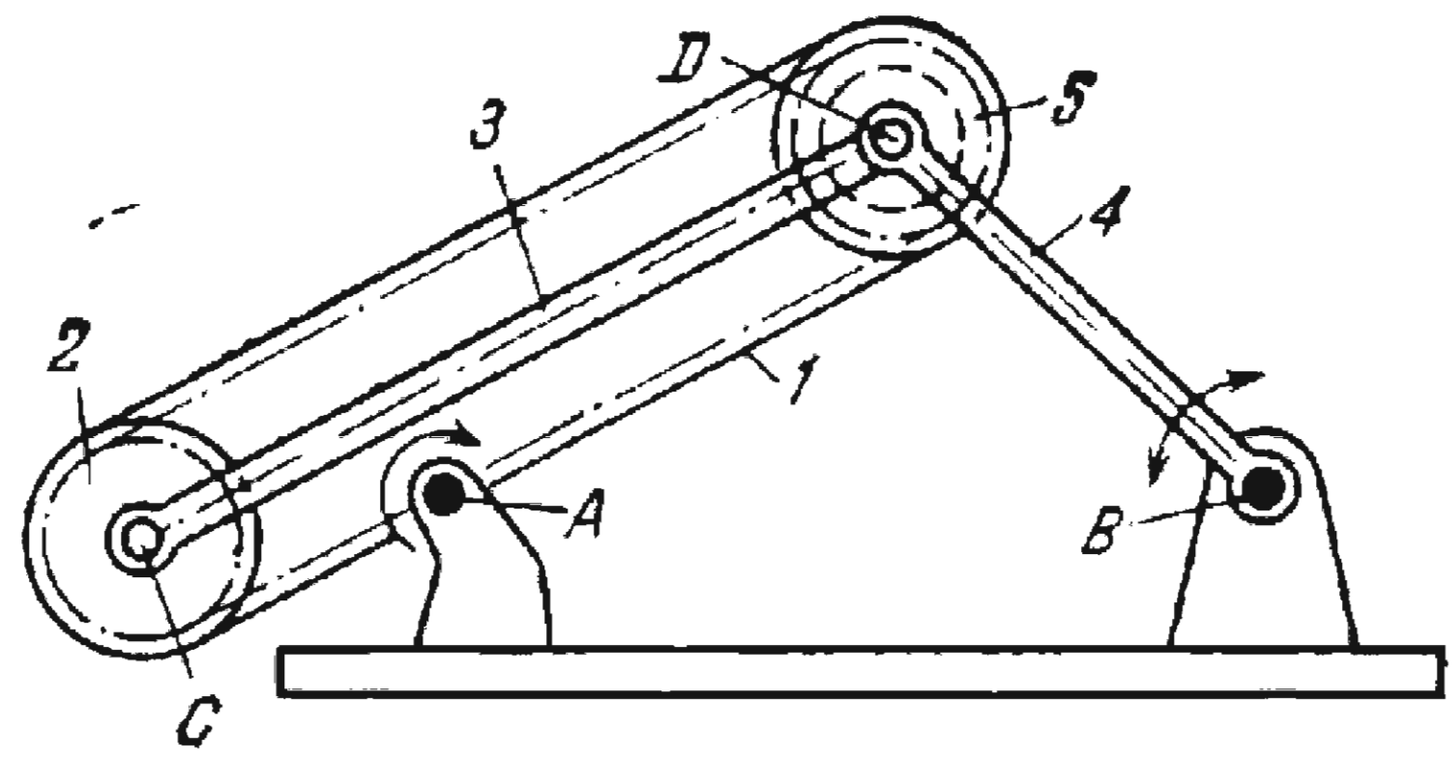
10. TILTING CRAWLER MECHANISMS
(1986 through 2016)

1986	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



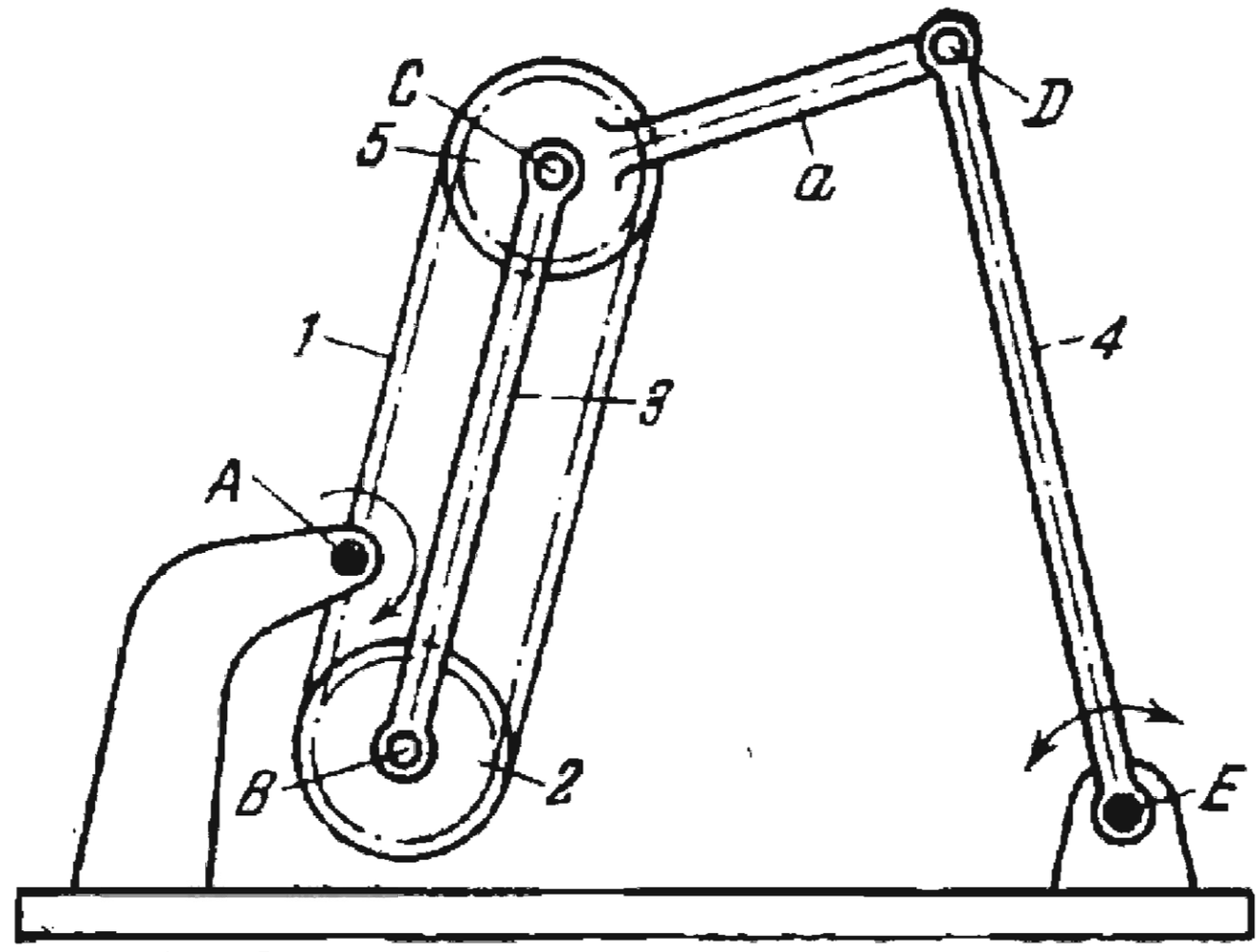
Flexible link *1* runs over pulleys *2* and *5*, of equal diameter, and oscillates about fixed axis *A*. Link *3*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *2* and *5* and by turning pair *E* to lever *4* which turns about fixed axis *B*. When flexible link *1* turns about xis *A*, link *3* has a complex motion and link *4* o cillates about axis *B*.

1987	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



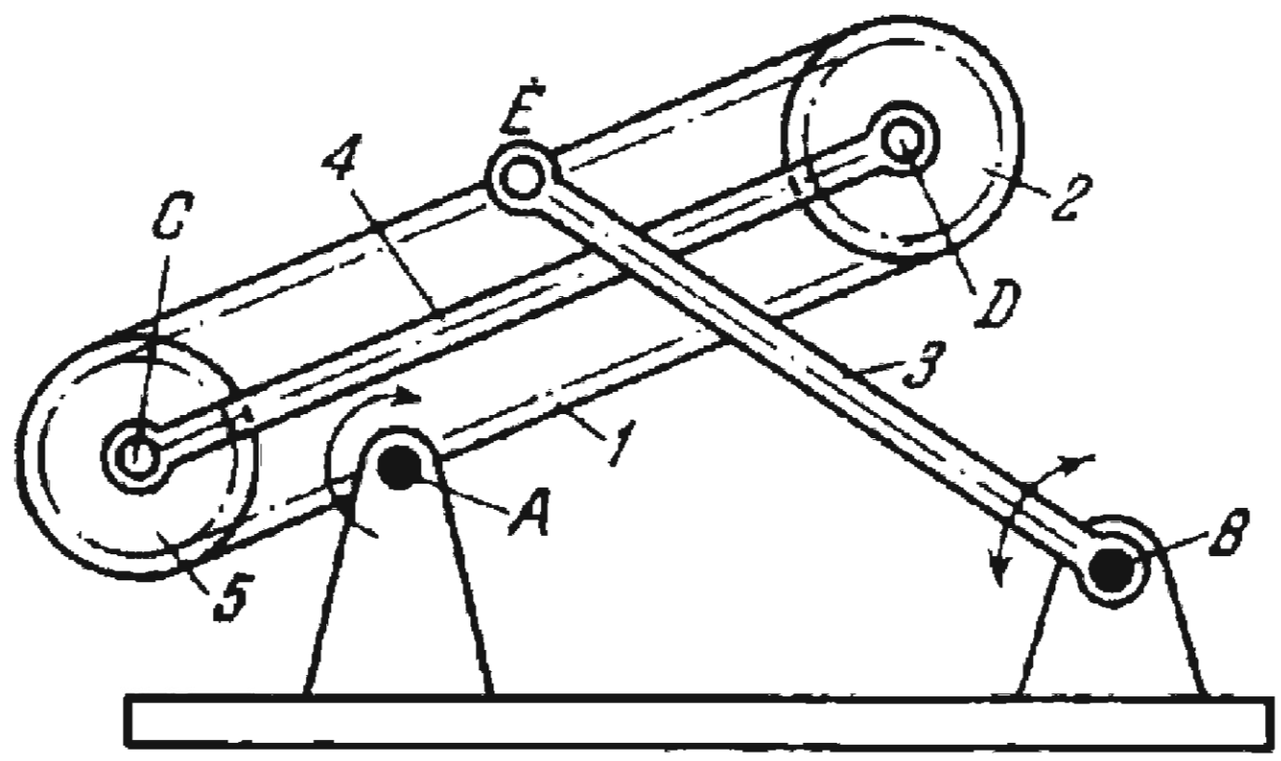
Flexible link *1* runs over pulleys *2* and *5*, of equal diameter, and oscillates about fixed axis *A*. Link *3* is connected by turning pairs *C* and *D* to pulleys *2* and *5*. Link *4* turns about fixed axis *B* and is connected by turning pair *D* to link *3*. When flexible link *1* turns about axis *A*, link *3* has a complex motion and link *4* oscillates about axis *B*.

1988	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



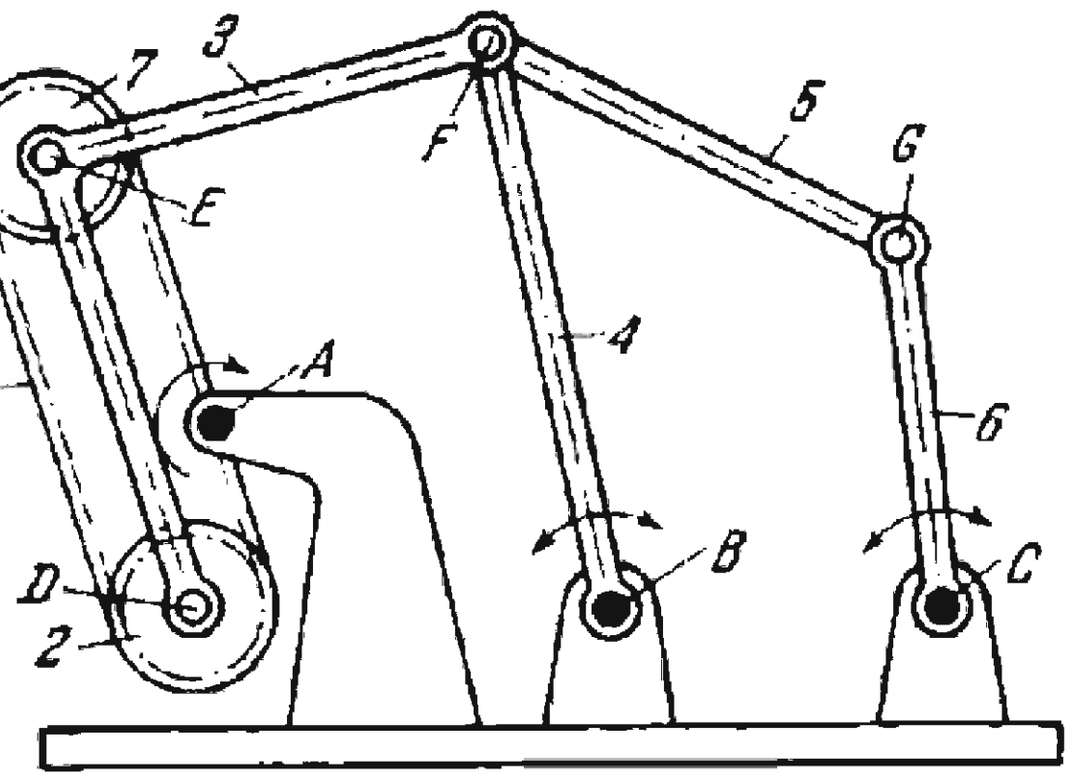
Flexible link *1* runs over pulleys *2* and *5*, of equal diameter, and oscillates about fixed axis *A*. Link *3* is connected by turning pairs *B* and *C* to pulleys *2* and *5*. Link *4* turns about fixed axis *E* and is connected by turning pair *D* to extension *a* of pulley *5*. When flexible link *1* turns about axis *A*, link *3* has a complex motion and link *4* oscillates about axis *E*.

1989	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



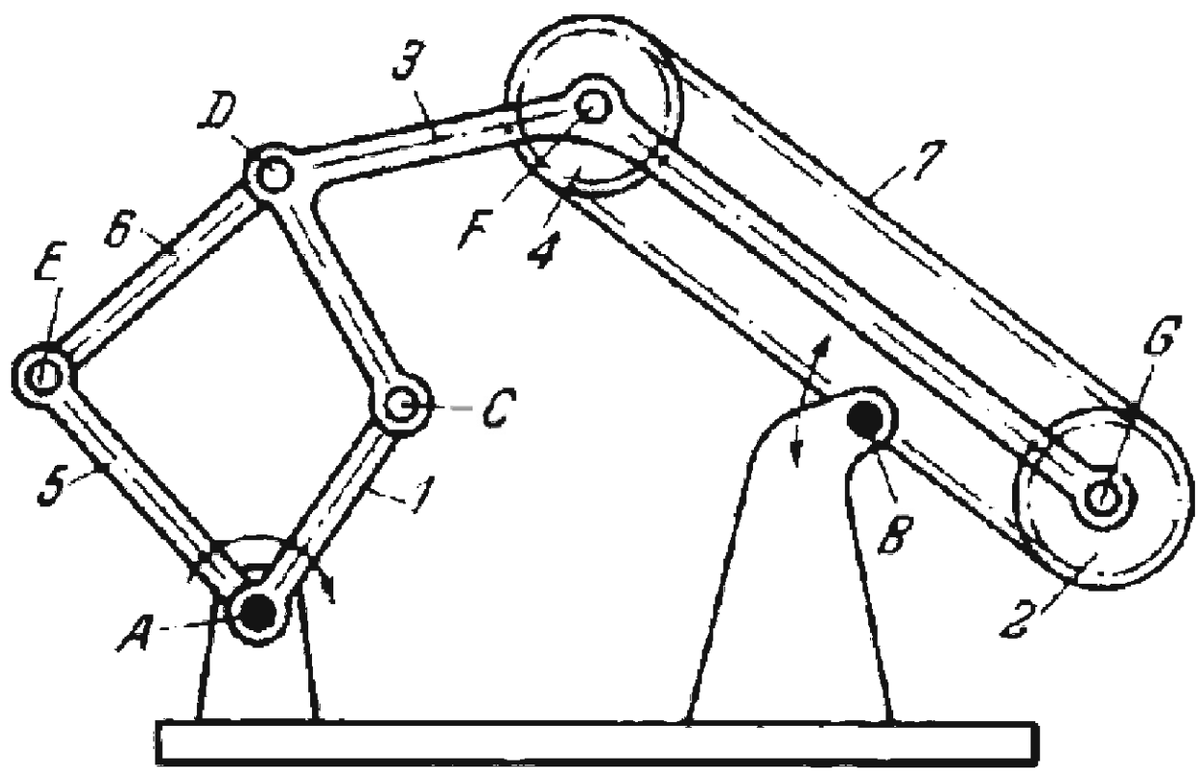
Flexible link *1* runs over pulleys *2* and *5*, of equal diameter, and oscillates about fixed axis *A*. Link *4* is connected by turning pairs *D* and *C* to pulleys *2* and *5*. Flexible link *1* is connected by turning pair *E* to link *3* which turns about fixed axis *B*. When flexible link *1* turns about axis *A*, link *4* has a complex motion and link *3* oscillates about axis *B*.

1990	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



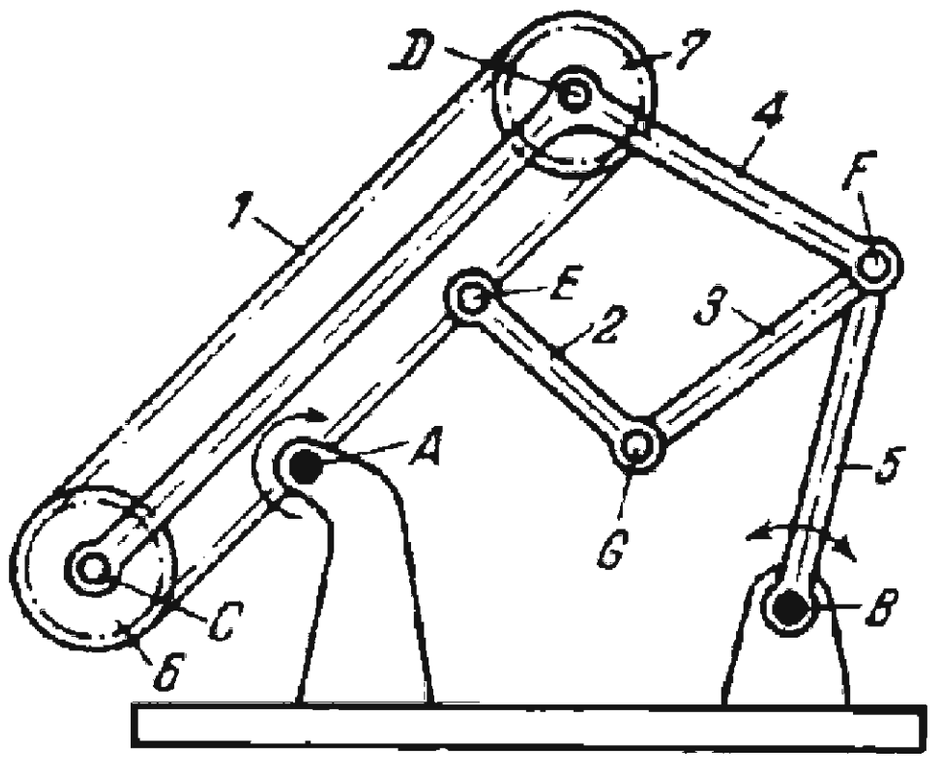
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *3*, designed as a bent lever, is connected by turning pairs *D* and *E* to pulleys *2* and *7* and by turning pair *F* to link *4* which turns about fixed axis *B*. Link *5* is connected by turning pairs *F* and *G* to links *3* and *4* and to link *6* which turns about fixed axis *C*. When flexible link *1* turns about axis *A*, links *3* and *5* have complex motions and links *4* and *6* oscillate about axes *B* and *C*.

1991	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



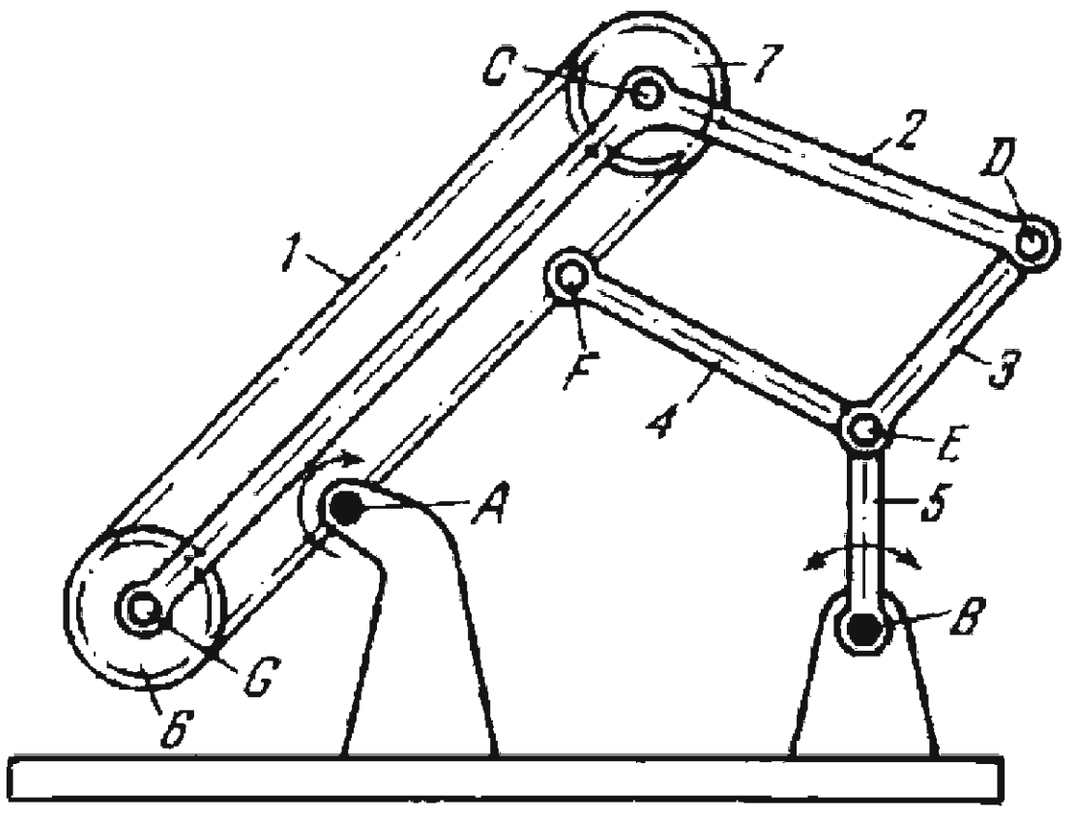
Flexible link *7* runs over pulleys *2* and *4*, of equal diameter, and oscillates about fixed axis *B*. Link *3*, designed as a complex lever, is connected by turning pairs *G* and *F* to pulleys *2* and *4* and by turning pairs *D* and *C* to links *6* and *1*. Links *1* and *5* turn about fixed axis *A*. Links *5* and *6* are connected together by turning pair *E*. When link *1* turns about axis *A*, links *3* and *6* have complex motions and link *5* and flexible link *7* oscillate about axes *A* and *B*.

1992	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



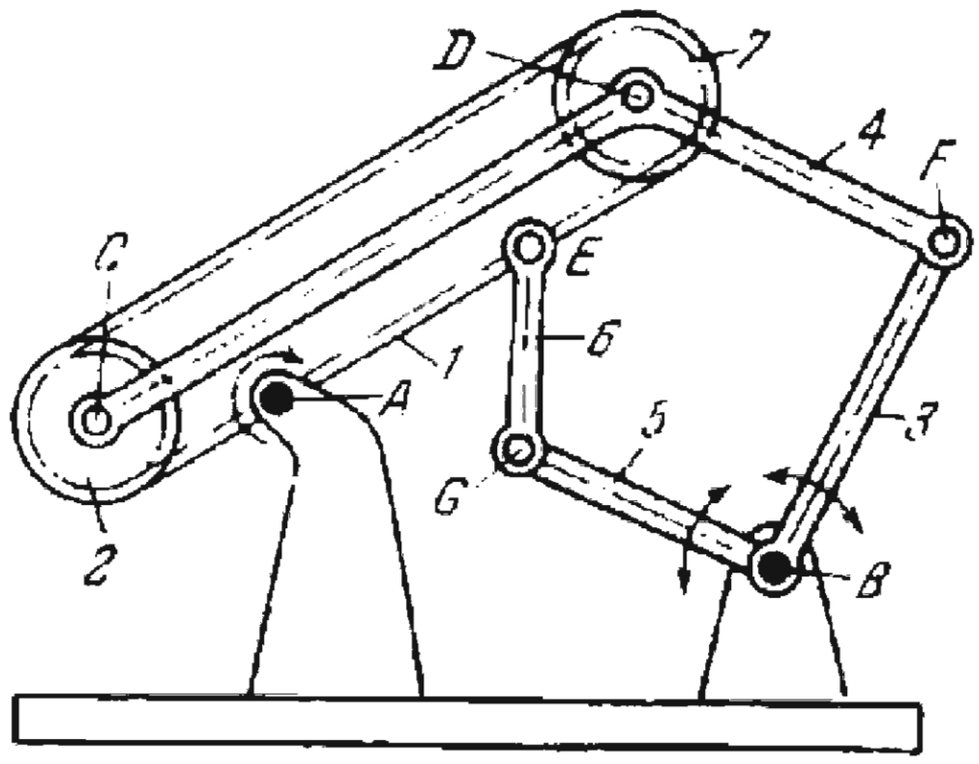
Flexible link *1* runs over pulleys *6* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *4*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *6* and *7* and by turning pair *F* to link *5* which turns about fixed axis *B*. Link *3* is connected by turning pairs *F* and *G* to link *5* and to link *2* which, in turn, is connected by turning pair *E* to flexible link *1*. When flexible link *1* turns about axis *A*, links *2*, *3* and *4* have complex motions and link *5* oscillates about axis *B*.

1993	HAIN LINKWORK TILTING CRAWLER MECHANISM	F TC



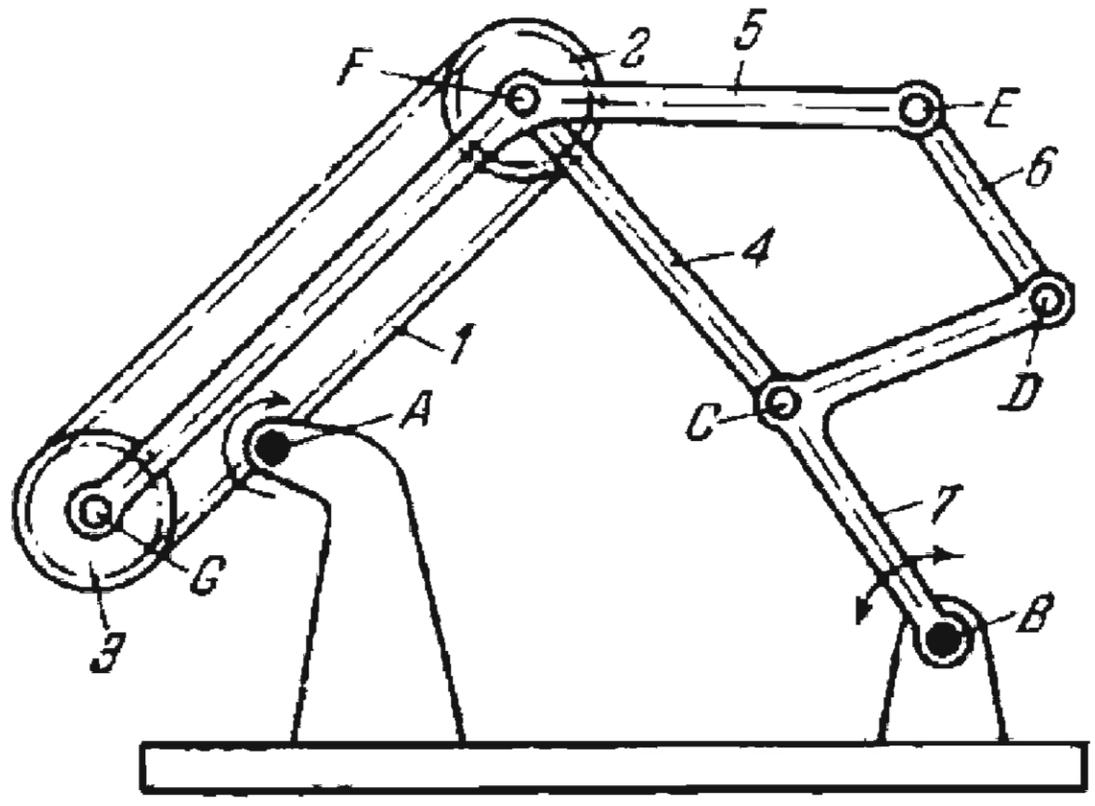
Flexible link *1* runs over pulleys *6* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *G* and *C* to pulleys *6* and *7* and by turning pair *D* to link *3*. Link *3* is connected by turning pair *E* to link *5* which turns about fixed axis *B*. Link *4* is connected by turning pairs *F* and *E* to flexible link *1* and to link *5*. When flexible link *1* turns about axis *A*, links *2*, *3* and *4* have complex motions and link *5* oscillates about axis *B*.

1994	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



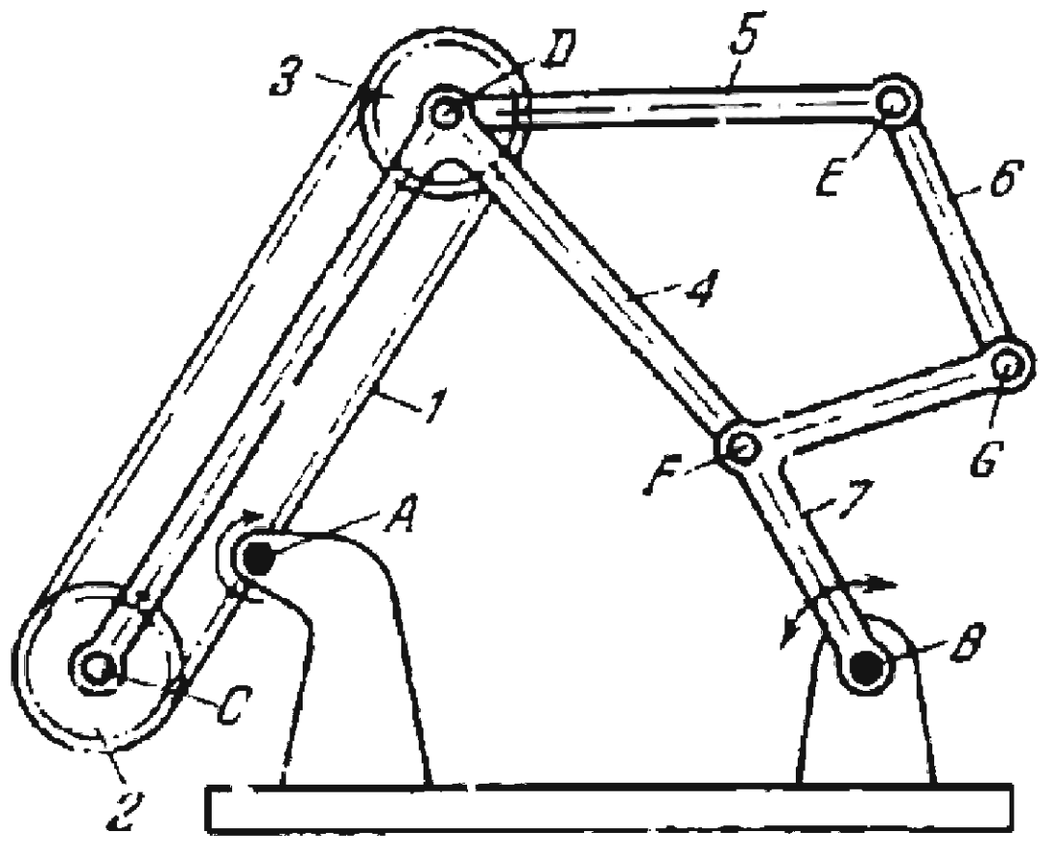
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *4*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *2* and *7* and by turning pair *F* to link *3* which turns about fixed axis *B*. Link *6* is connected by turning pairs *E* and *G* to flexible link *1* and to link *5* which turns about axis *B*. When flexible link *1* turns about axis *A*, links *4* and *6* have complex motions and links *3* and *5* oscillate about axis *B*.

1995	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



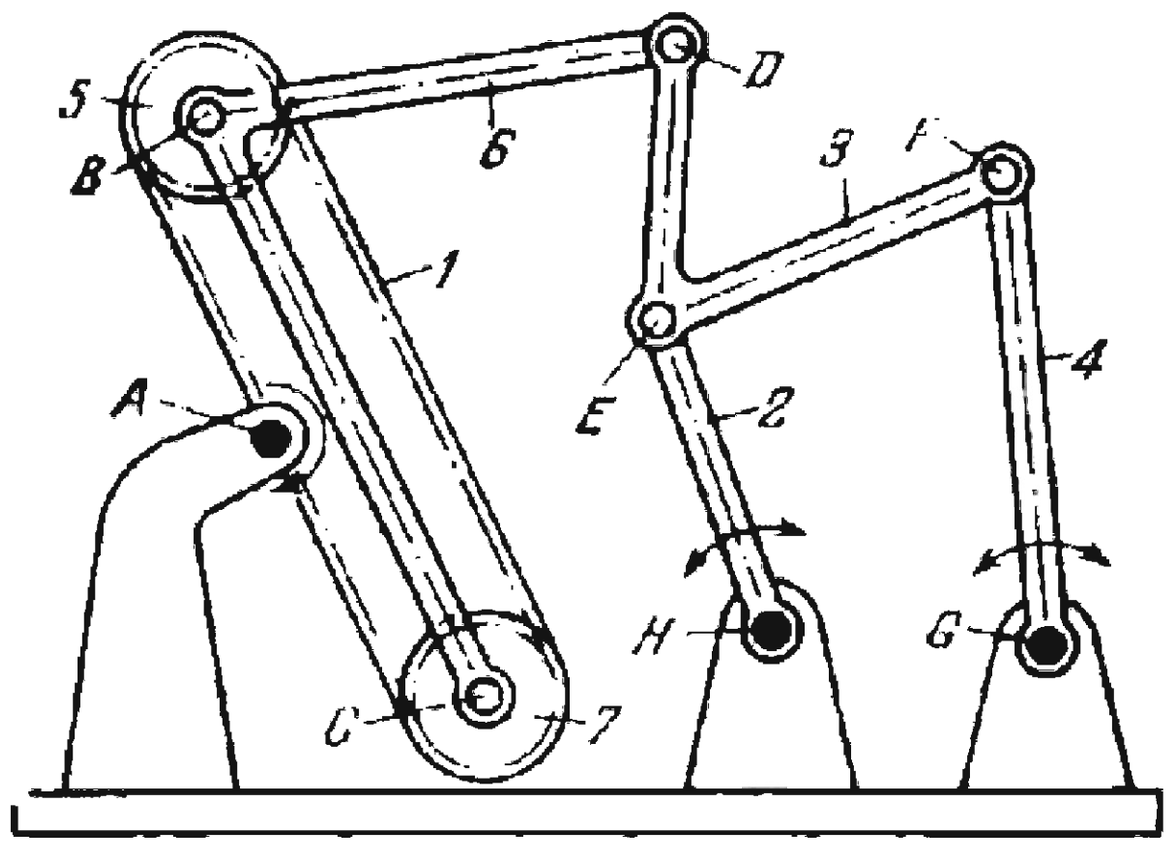
Flexible link *1* runs over pulleys *2* and *3*, of equal diameter, and oscillates about fixed axis *A*. Link *5*, designed as a bent lever, is connected by turning pairs *F* and *G* to pulleys *2* and *3* and by turning pair *E* to link *6*. Link *7*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *C* and *D* to links *4* and *6*. Link *4* is connected by turning pair *F* to link *5*. When flexible link *1* turns about axis *A*, links *4*, *5* and *6* have complex motions and link *7* oscillates about axis *B*.

1996	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



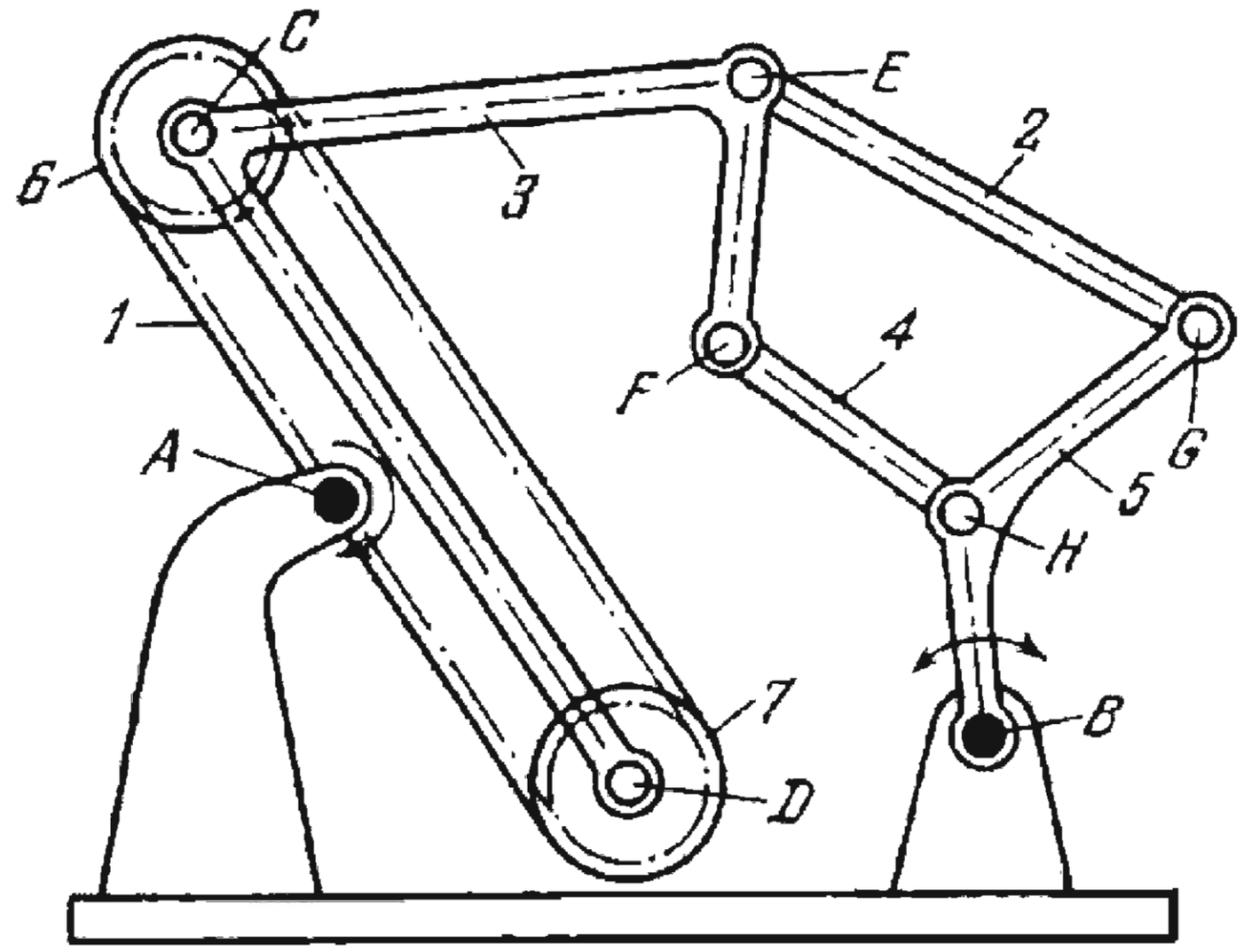
Flexible link *1* runs over pulleys *2* and *3*, of equal diameter, and oscillates about fixed axis *A*. Link *4*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *2* and *3*. Link *7*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *F* and *G* to links *4* and *6*. Link *5* is connected by turning pairs *D* and *E* to links *4* and *6*. When flexible link *1* turns about axis *A*, links *4*, *5* and *6* have complex motions and link *7* oscillates about axis *B*.

1997	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



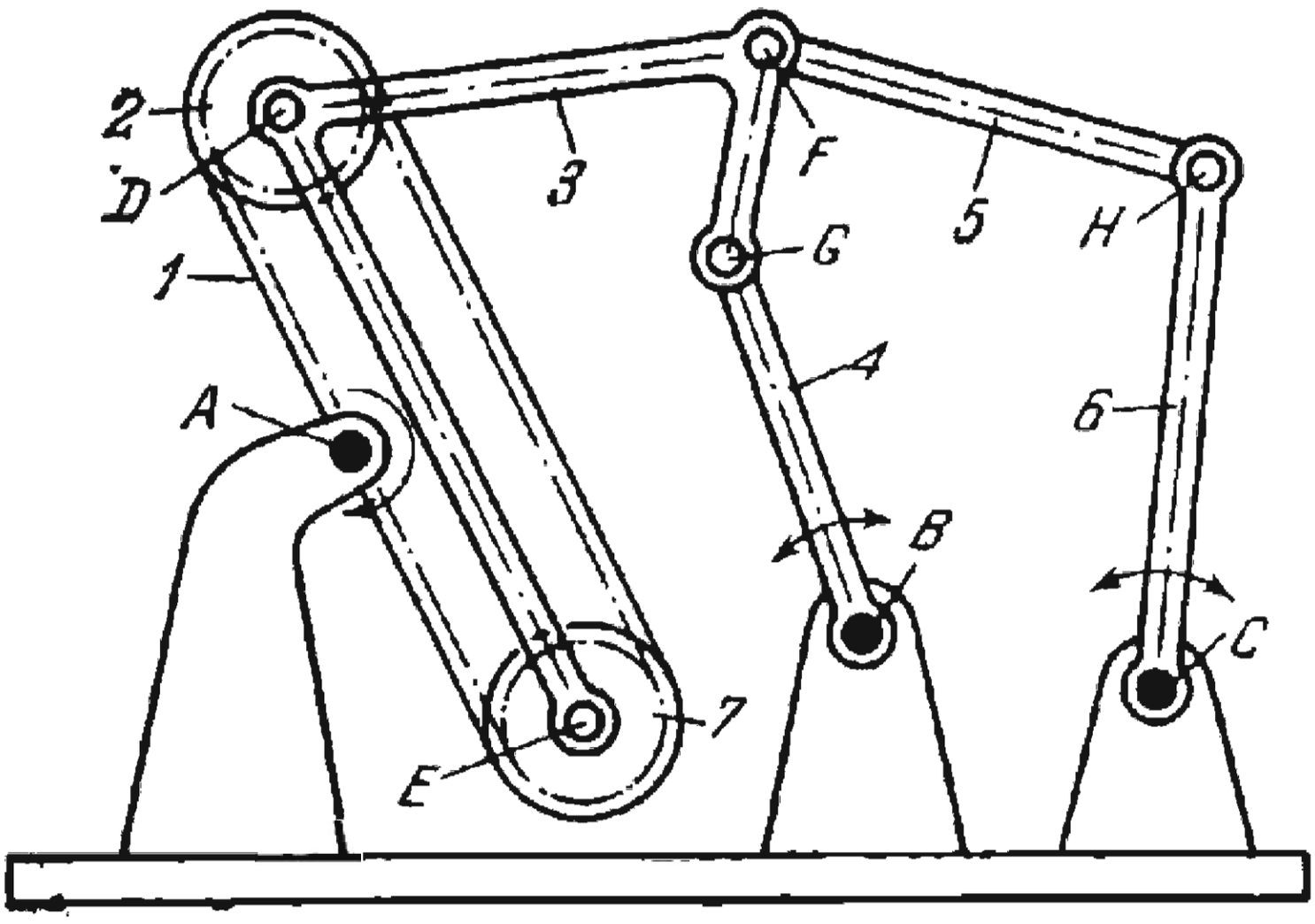
Flexible link *1* runs over pulleys *5* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *6*, designed as a bent lever, is connected by turning pairs *B* and *C* to pulleys *5* and *7*, and by turning pair *D* to link *3* which is also designed as a bent lever. Links *2* and *4* turn about fixed axes *H* and *G* and are connected by turning pairs *E* and *F* to link *3*. When flexible link *1* turns about axis *A*, links *3* and *6* have complex motions and links *2* and *4* oscillate about axes *H* and *G*.

1998	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



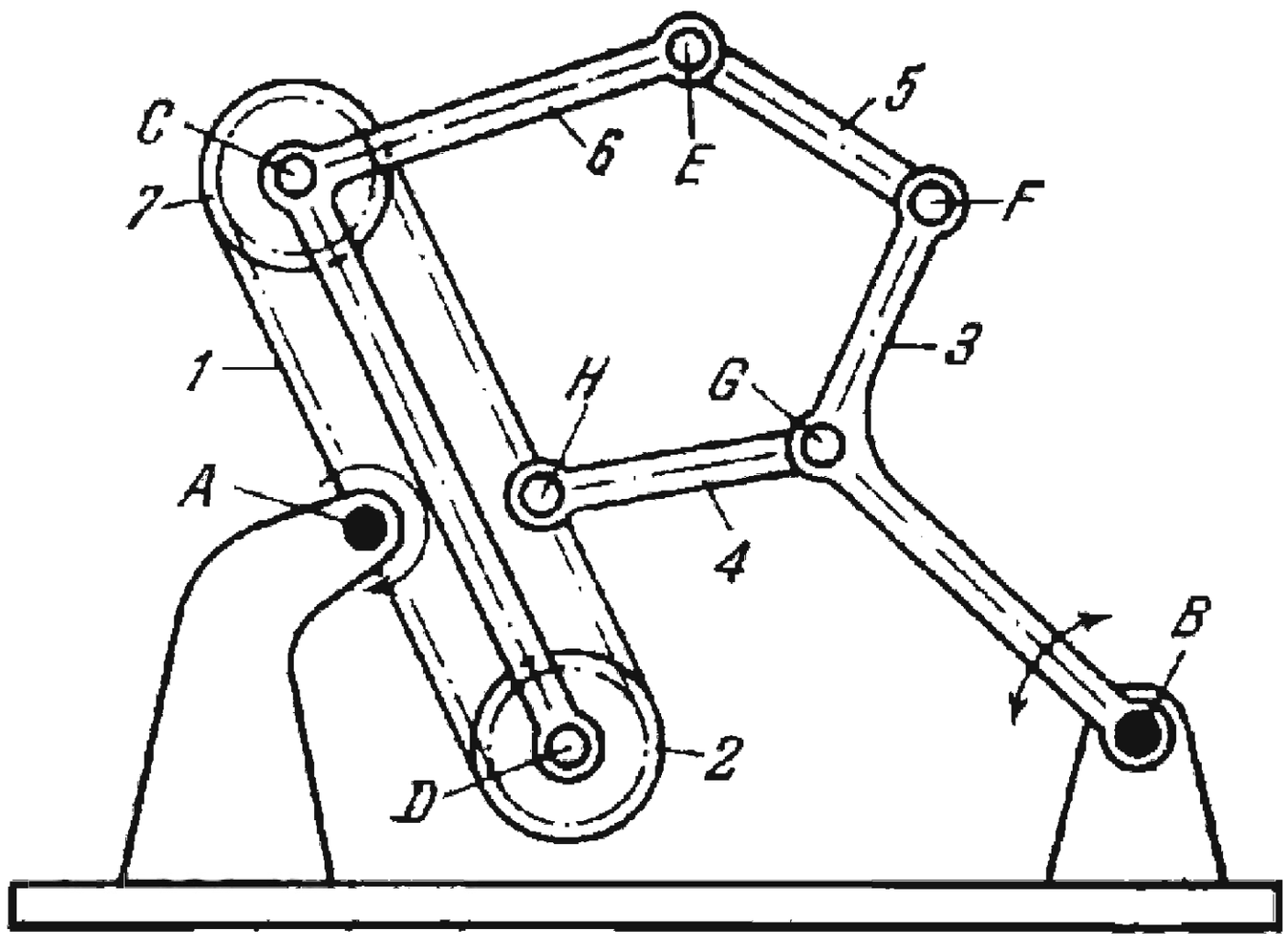
Flexible link *1* runs over pulleys *6* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *3*, designed as a complex lever, is connected by turning pairs *C* and *D* to pulleys *6* and *7* and by turning pairs *E* and *F* to links *2* and *4*. Link *5*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *G* and *H* to links *2* and *4*. When flexible link *1* turns about axis *A*, links *2*, *3* and *4* have complex motions and link *5* oscillates about axis *B*.

1999	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



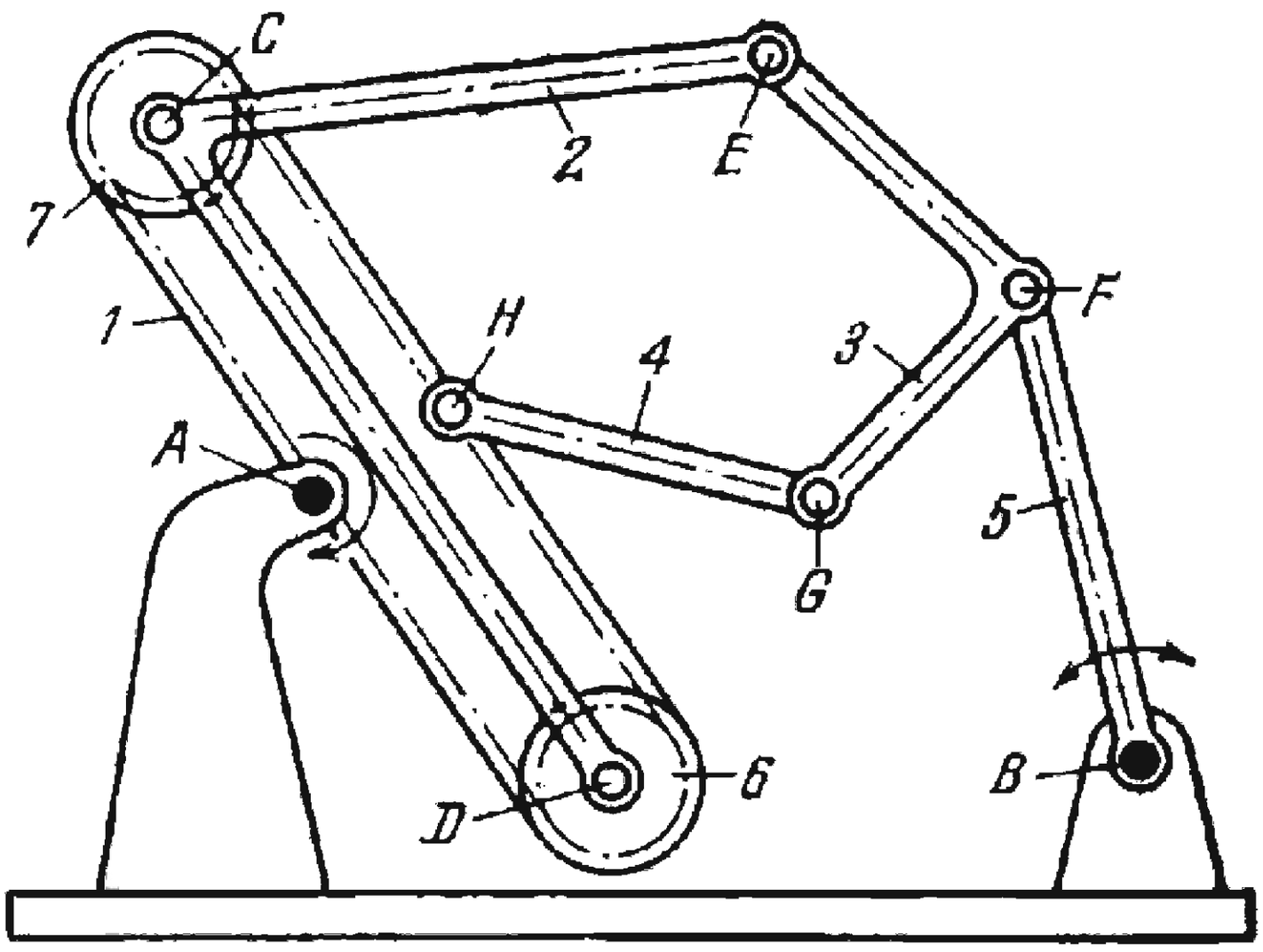
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *3*, designed as a complex lever, is connected by turning pairs *D* and *E* to pulleys *2* and *7* and by turning pairs *F* and *G* to links *5* and *4*. Link *4* turns about fixed axis *B*. Link *6* turns about fixed axis *C* and is connected by turning pair *H* to link *5*. When flexible link *1* turns about axis *A*, links *3* and *5* have complex motions and links *4* and *6* oscillate about axes *B* and *C*.

2000	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



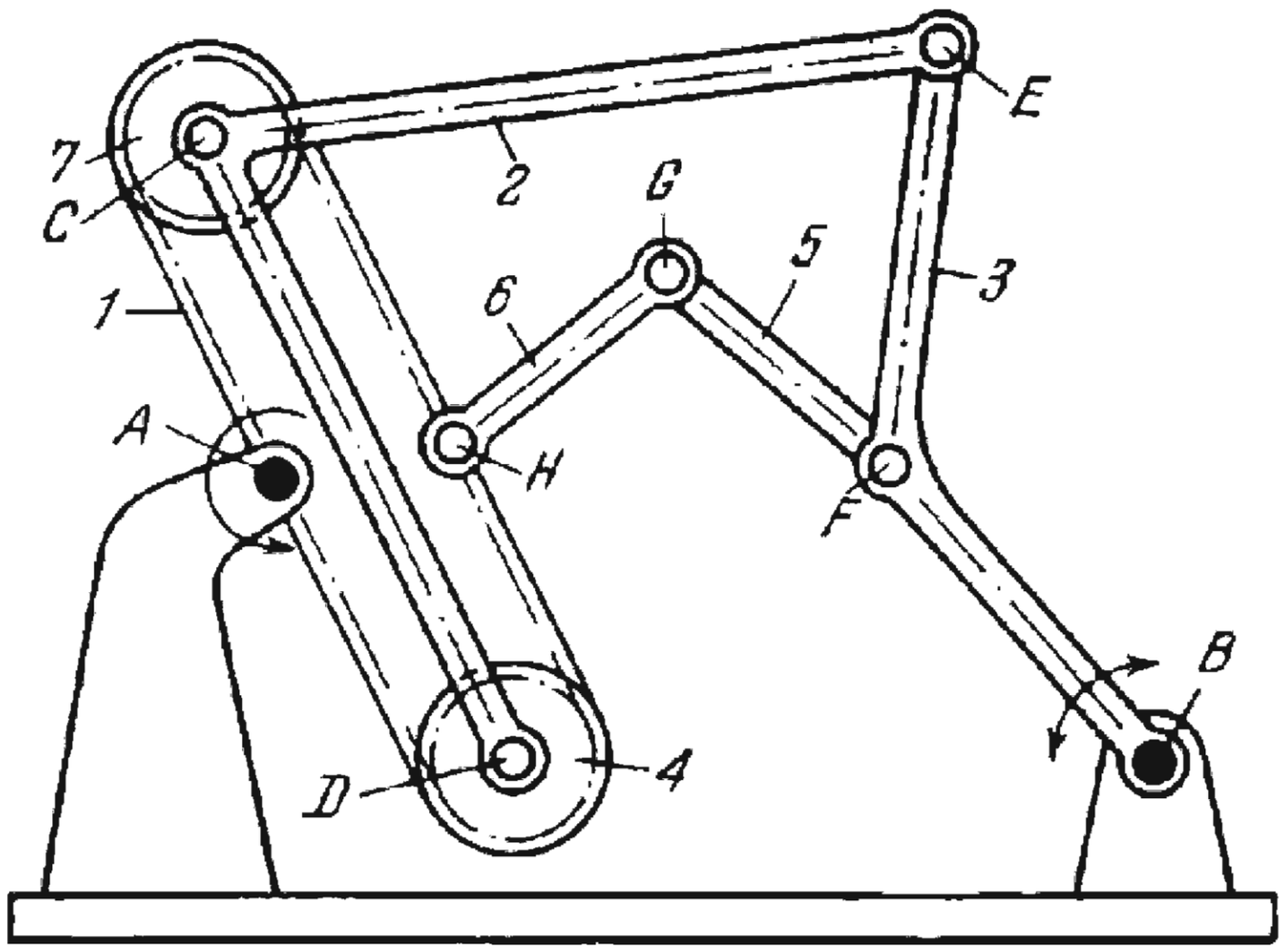
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *6*, designed as a bent lever, is connected by turning pairs *D* and *C* to pulleys *2* and *7* and by turning pair *E* to link *5*. Link *3*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *F* and *G* to link *5* and to link *4* which, in turn, is connected by turning pair *H* to flexible link *1*. When flexible link *1* turns about axis *A*, links *4*, *5* and *6* have complex motions and link *3* oscillates about axis *B*.

2001	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC

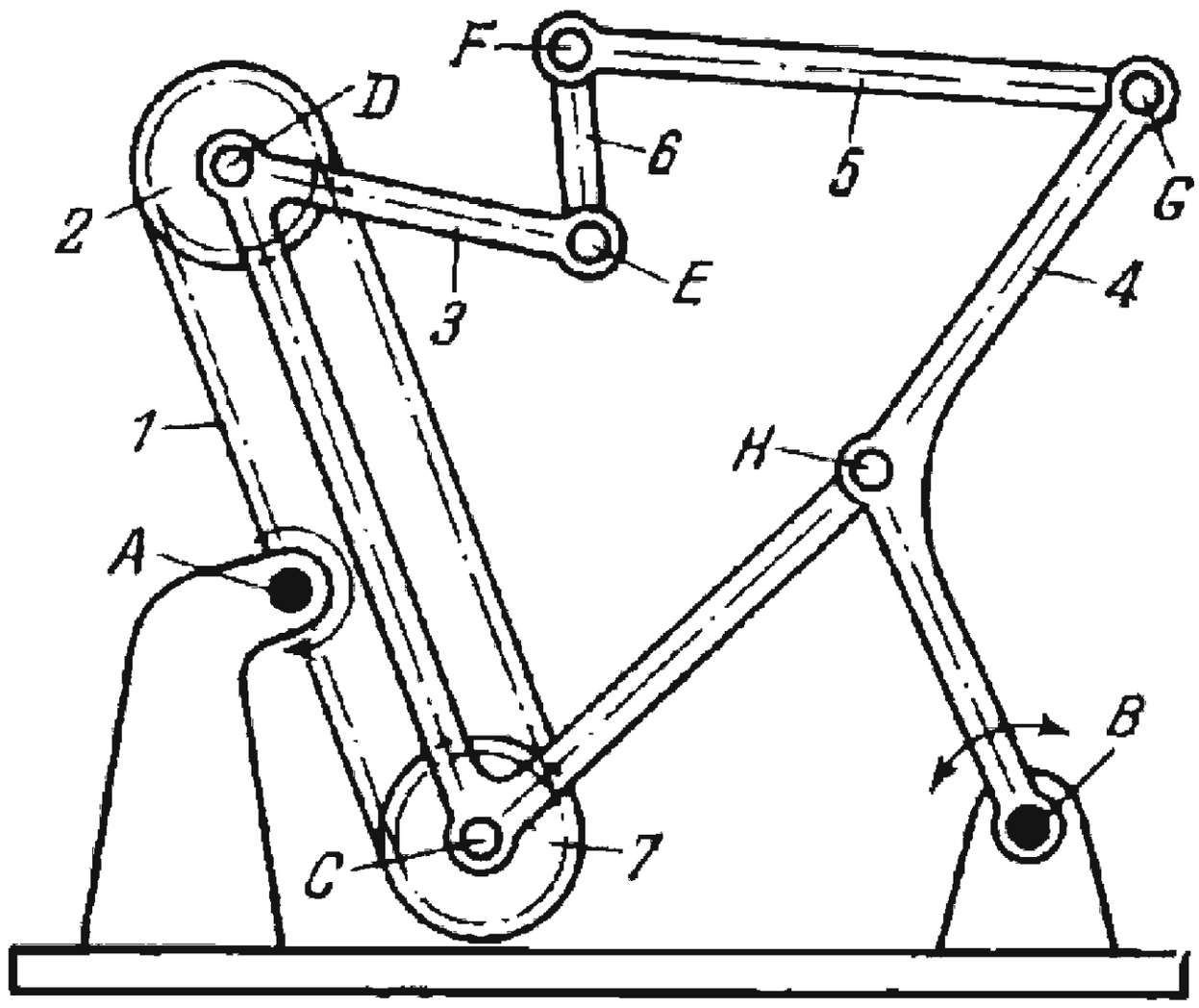


Flexible link *1* runs over pulleys *6* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *D* and *C* to pulleys *6* and *7* and by turning pair *E* to link *3*, also designed as a bent lever. Link *4* is connected by turning pairs *G* and *H* to link *3* and to flexible link *1*. Link *5* turns about fixed axis *B* and is connected by turning pair *F* to link *3*. When flexible link *1* turns about axis *A*, links *2*, *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2002	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC

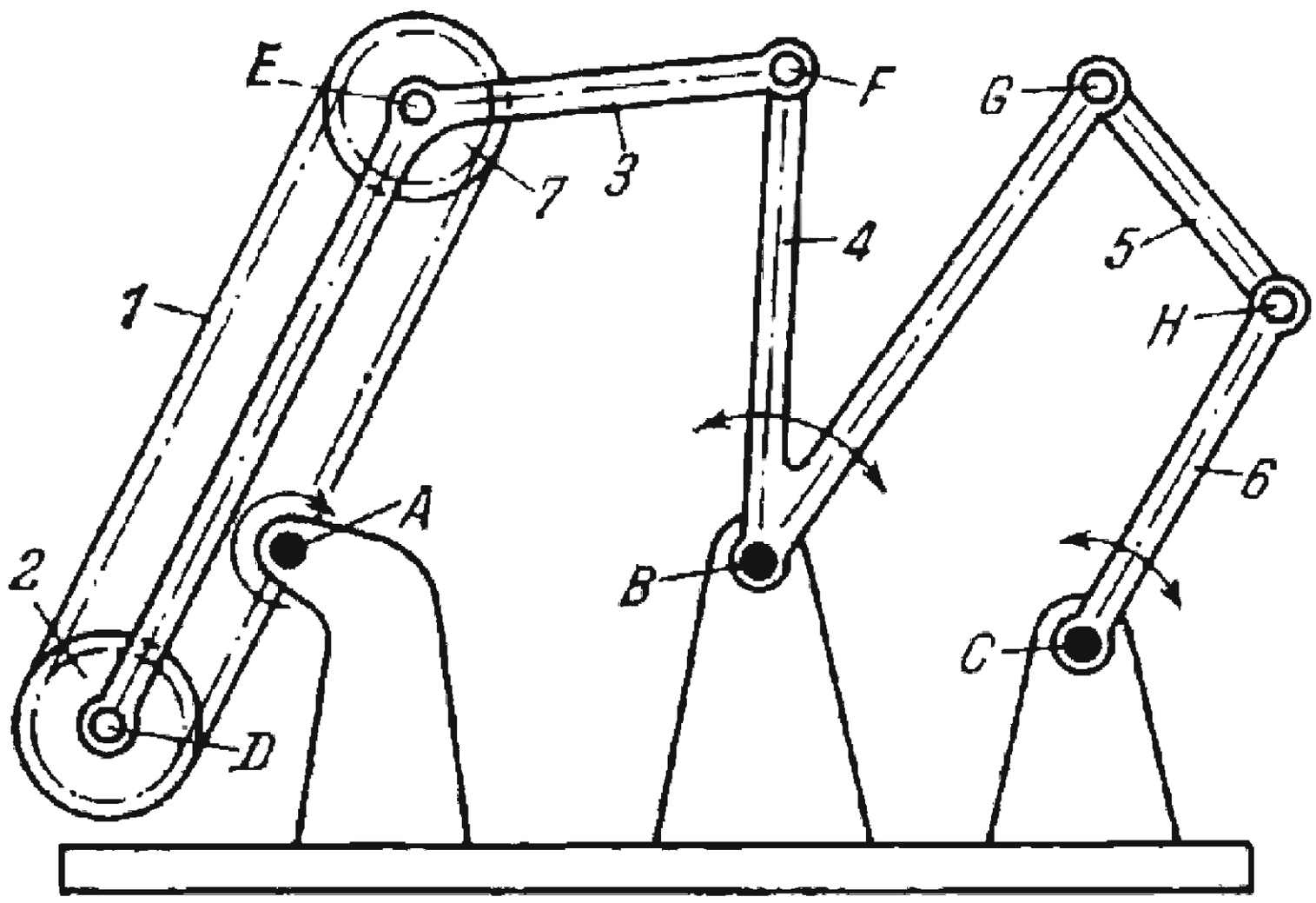


Flexible link *1* runs over pulleys *4* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *D* and *C* to pulleys *4* and *7* and by turning pair *E* to link *3* which turns about fixed axis *B*. Link *3*, designed as a bent lever, is connected by turning pair *F* to link *5*. Link *6* is connected by turning pairs *G* and *H* to link *5* and to flexible link *1*. When flexible link *1* turns about axis *A*, links *2*, *5* and *6* have complex motions and link *3* oscillates about axis *B*.



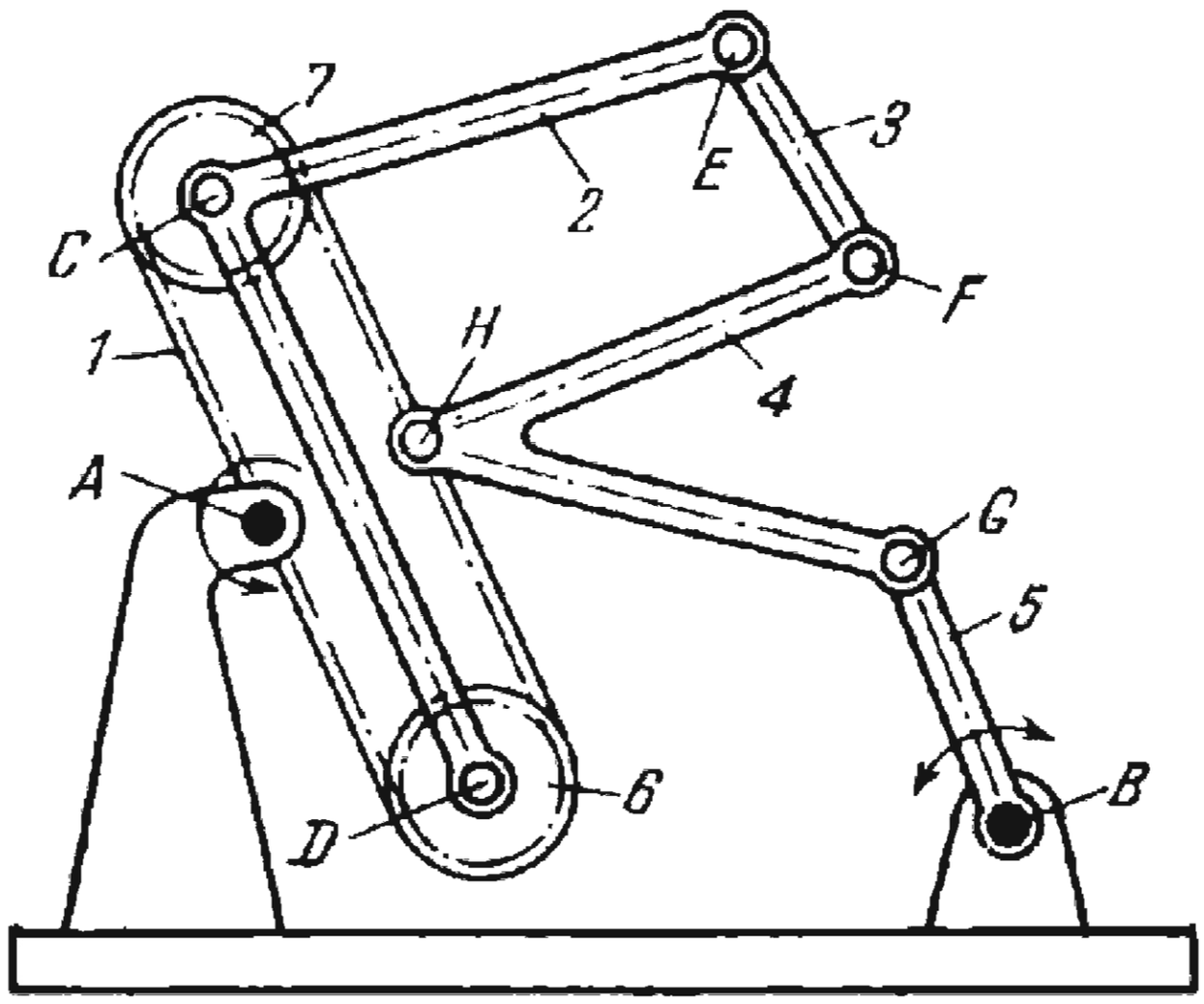
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *3*, designed as a complex lever, is connected by turning pairs *D* and *C* to pulleys *2* and *7* and by turning pairs *E* and *H* to links *6* and *4*. Link *5* is connected by turning pairs *F* and *G* to link *6* and to link *4*, designed as a bent lever which turns about fixed axis *B*. When flexible link *1* turns about axis *A*, links *3*, *5* and *6* have complex motions and link *4* oscillates about axis *B*.

2004	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



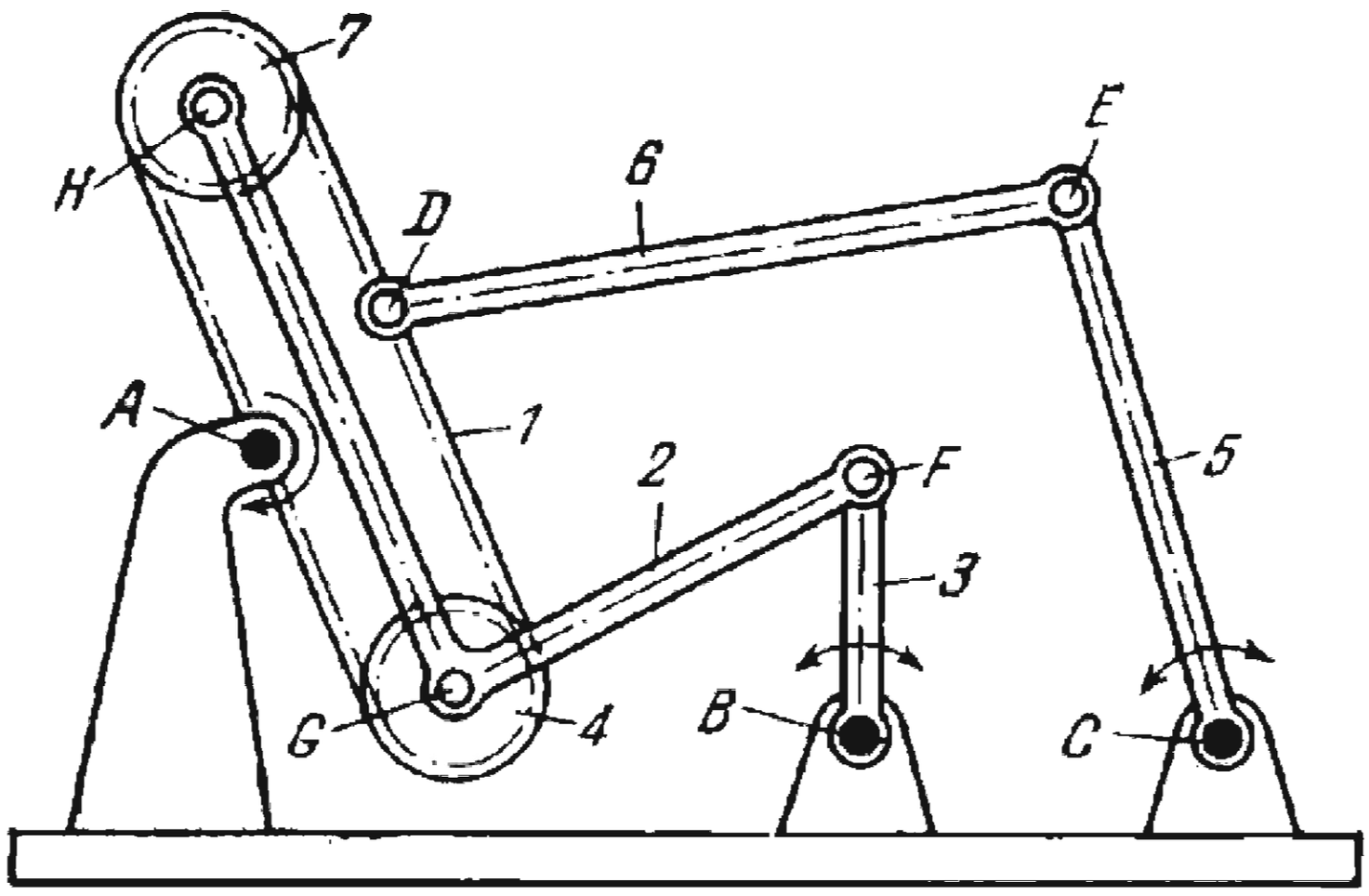
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *3*, designed as a bent lever, is connected by turning pairs *D* and *E* to pulleys *2* and *7* and by turning pair *F* to link *4*. Link *4*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pair *G* to link *5*. Link *6* turns about fixed axis *C* and is connected by turning pair *H* to link *5*. When flexible link *1* turns about axis *A*, links *3* and *5* have complex motions and links *4* and *6* oscillate about axes *B* and *C*.

2005	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



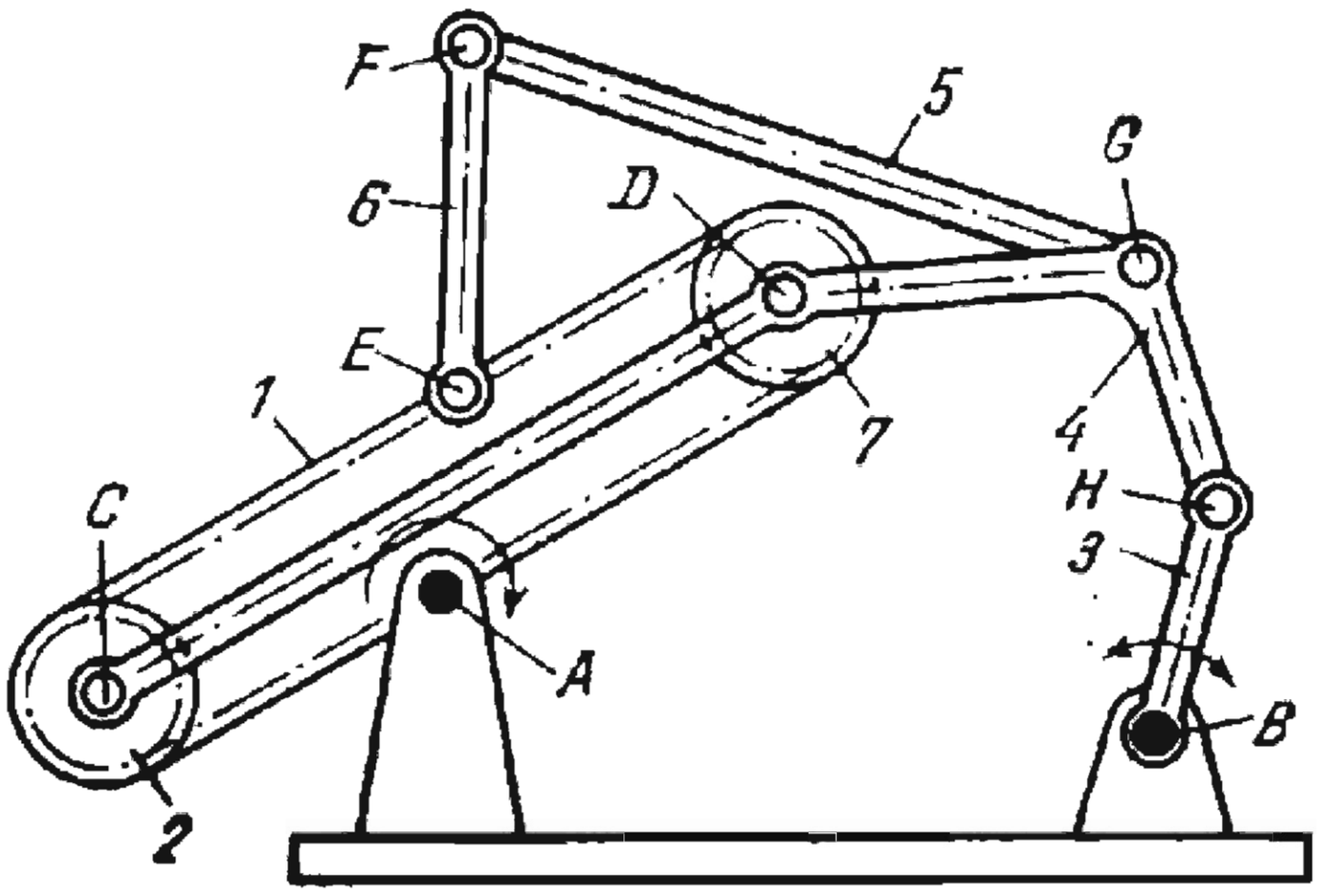
Flexible link *1* runs over pulleys *6* and *7*, of equal diameter and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *D* and *C* to pulleys *6* and *7* and by turning pair *E* to link *3*. Link *4*, designed as a bent lever, is connected by turning pairs *F*, *H* and *G* to link *3*, flexible link *1* and to link *5* which turns about fixed axis *B*. When flexible link *1* turns about axis *A*, links *2*, *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2006	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



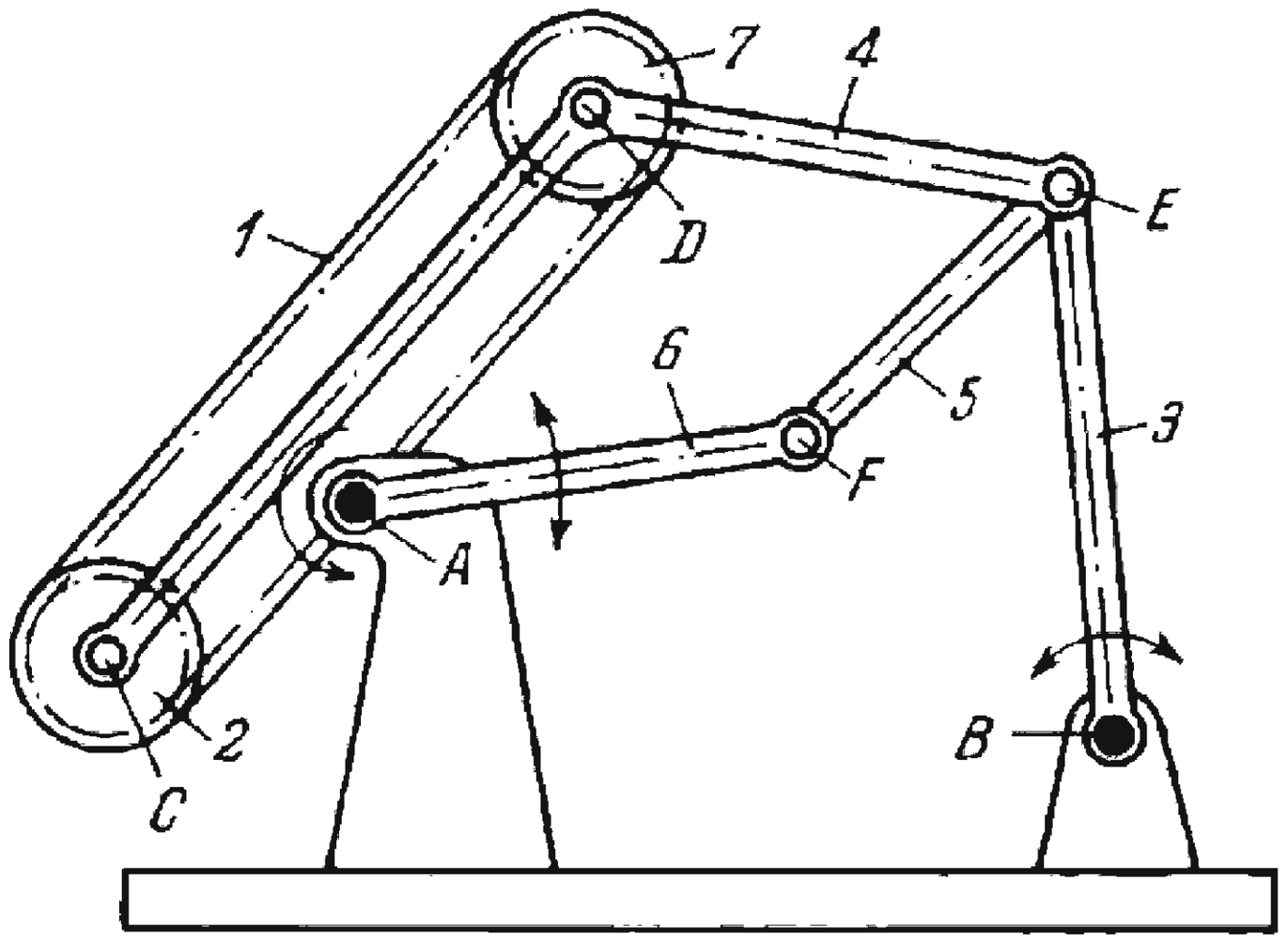
Flexible link *1* runs over pulleys *4* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *G* and *H* to pulleys *4* and *7* and by turning pair *F* to link *3* which turns about fixed axis *B*. Link *6* is connected by turning pairs *D* and *E* to flexible link *1* and to link *5* which turns about fixed axis *C*. When flexible link *1* turns about axis *A*, links *2* and *6* have complex motions and links *3* and *5* oscillate about axes *B* and *C*.

2007	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



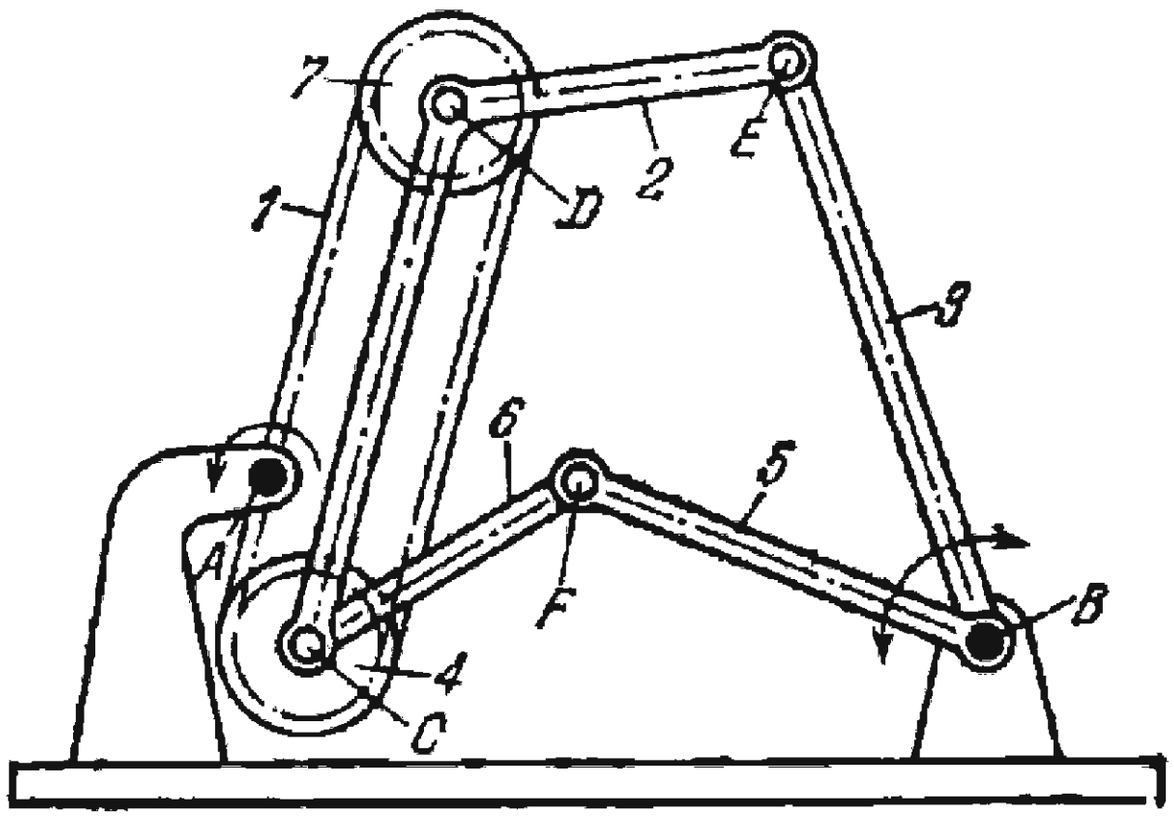
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *4*, designed as a complex lever, is connected by turning pairs *C* and *D* to pulleys *2* and *7*, and by turning pairs *G* and *H* to link *5* and to link *3* which turns about fixed axis *B*. Link *6* is connected by turning pairs *E* and *F* to flexible link *1* and to link *5*. When flexible link *1* turns about axis *A*, links *4*, *5* and *6* have complex motions and link *3* oscillates about axis *B*.

2008	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



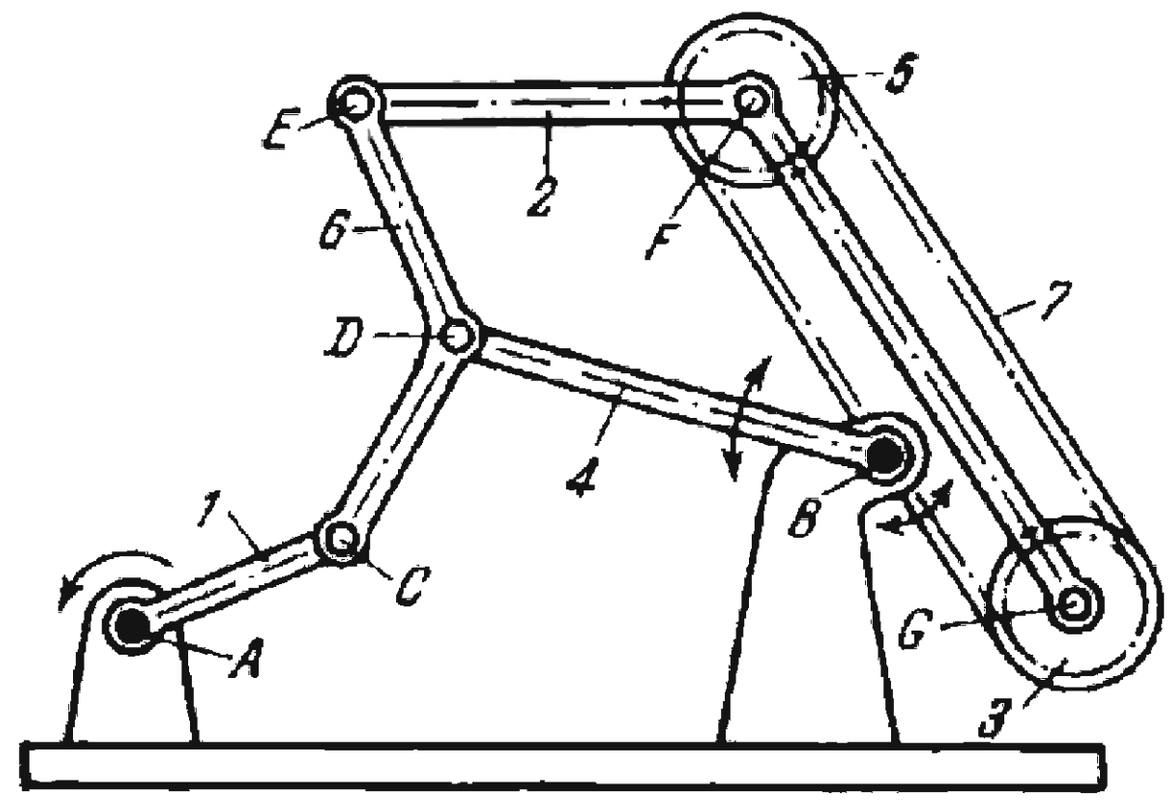
Flexible link *1* runs over pulleys *2* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *4*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *2* and *7* and by turning pairs *E* to link *5* and to link *3* which turns about fixed axis *B*. Link *6* turns about axis *A* and is connected by turning pair *F* to link *5*. When flexible link *1* turns about axis *A*, links *4* and *5* have complex motions and links *3* and *6* oscillate about axes *B* and *A*.

2009	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



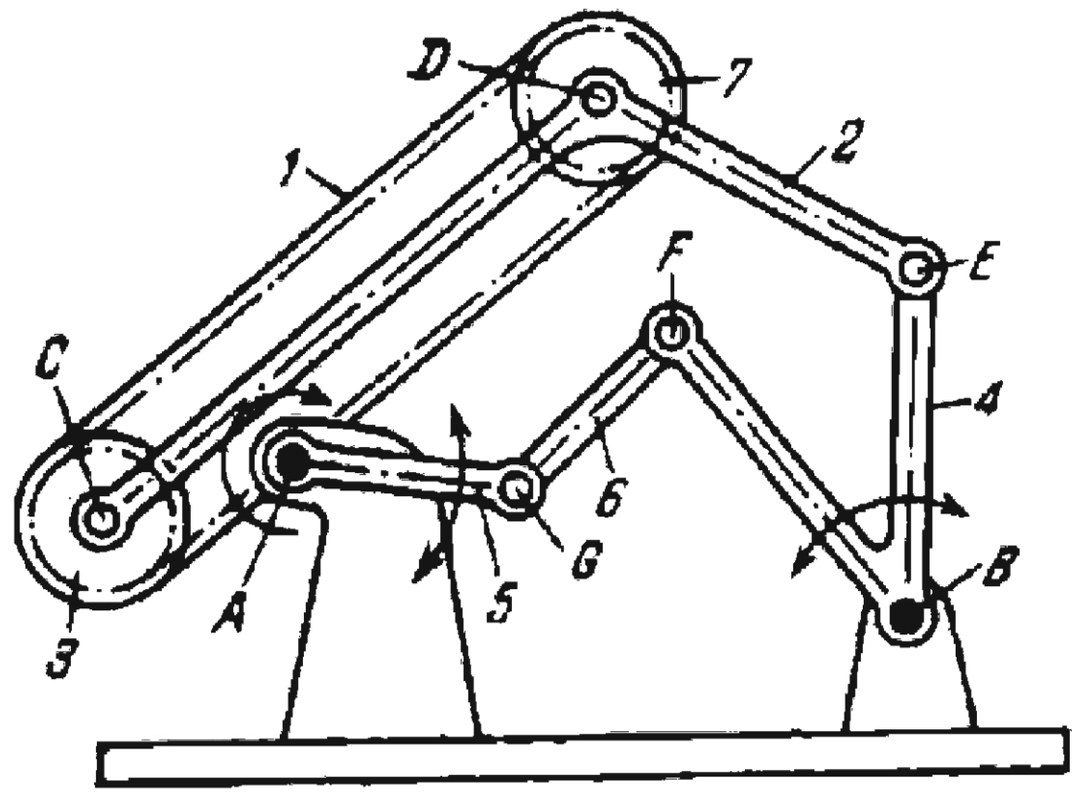
Flexible link *1* runs over pulleys *4* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *4* and *7* and by turning pair *E* to link *3* which turns about fixed axis *B*. Link *6* is connected by turning pairs *C* and *F* to link *2* and to link *5* which turns about axis *B*. When flexible link *1* turns about axis *A*, links *2* and *6* have complex motions and links *3* and *5* oscillate about axis *B*.

2010	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



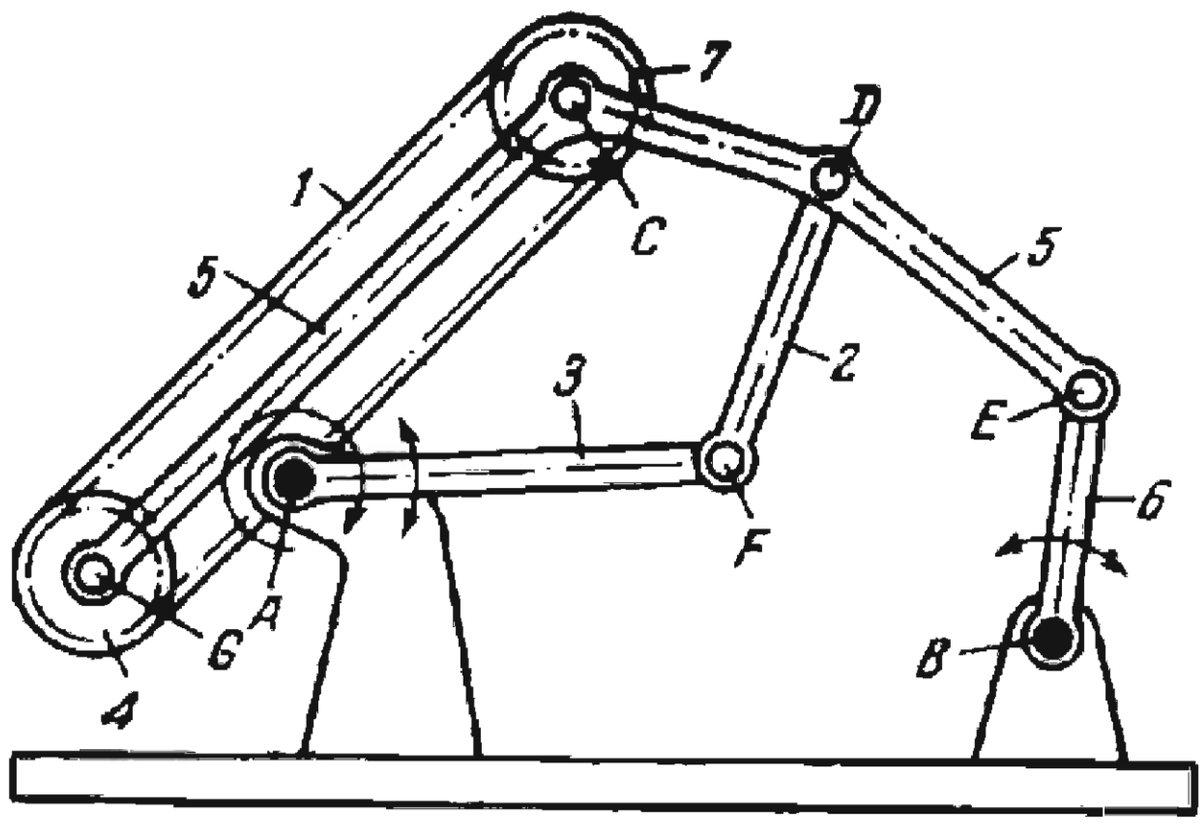
Flexible link *7* runs over pulleys *3* and *5*, of equal diameter, and oscillates about fixed axis *B*. Link *2*, designed as a bent lever, is connected by turning pairs *G* and *F* to pulleys *3* and *5* and by turning pair *E* to link *6*, also designed as a bent lever. Link *6* is connected by turning pairs *D* and *C* to link *4* which turns about fixed axis *B* and to link *1* which rotates about fixed axis *A*. When link *1* rotates about axis *A*, links *2* and *6* have complex motions and link *4* and flexible link *7* oscillate about axis *B*.

2011	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



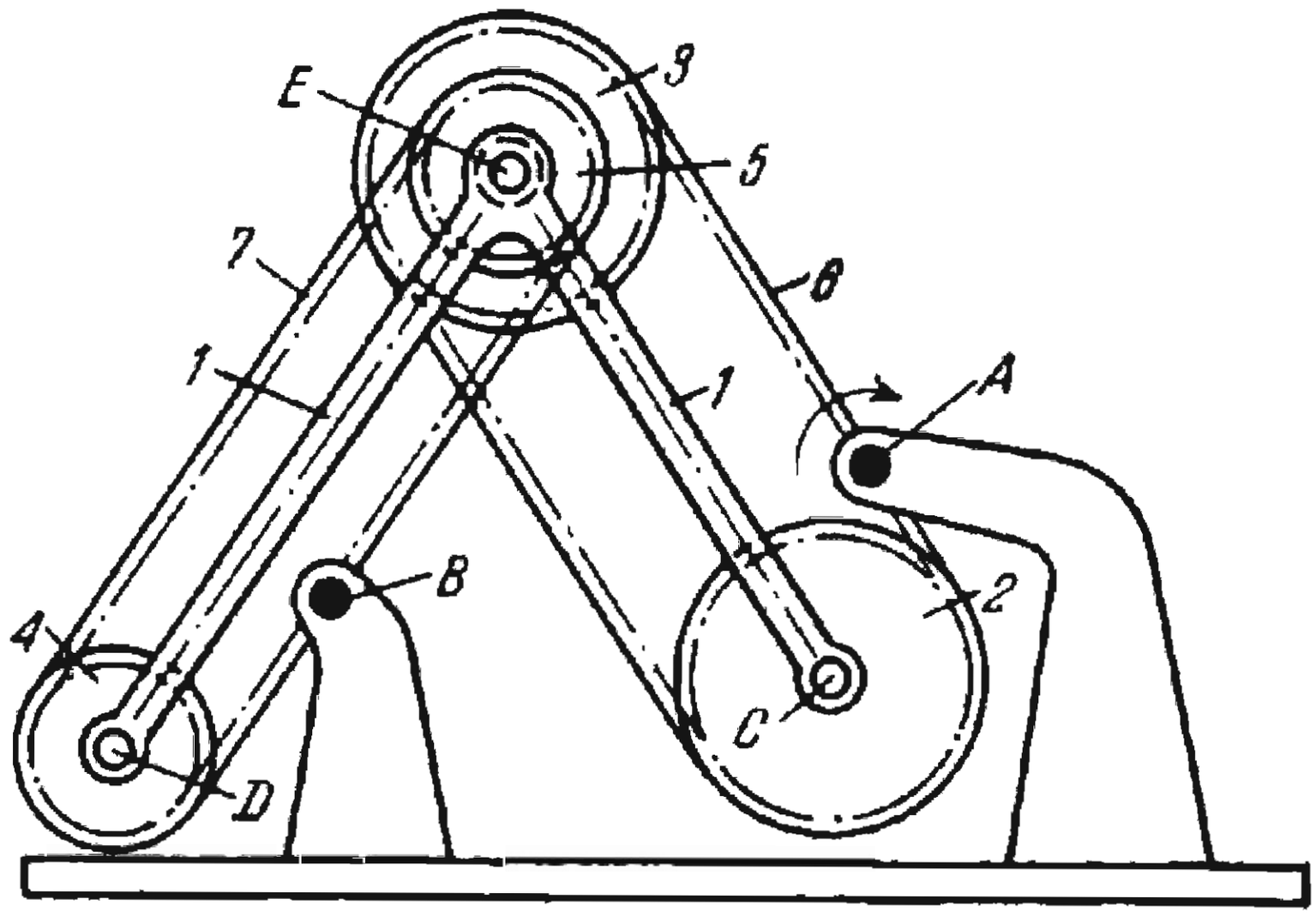
Flexible link *1* runs over pulleys *3* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *2*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *3* and *7* and by turning pair *E* to link *4* which turns about fixed axis *B* and is also designed as a bent lever. Link *6* is connected by turning pairs *F* and *G* to link *4* and to link *5* which turns about axis *A*. When flexible link *1* turns about axis *A*, links *2* and *6* have complex motions and links *4* and *5* oscillate about axes *B* and *A*.

2012	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



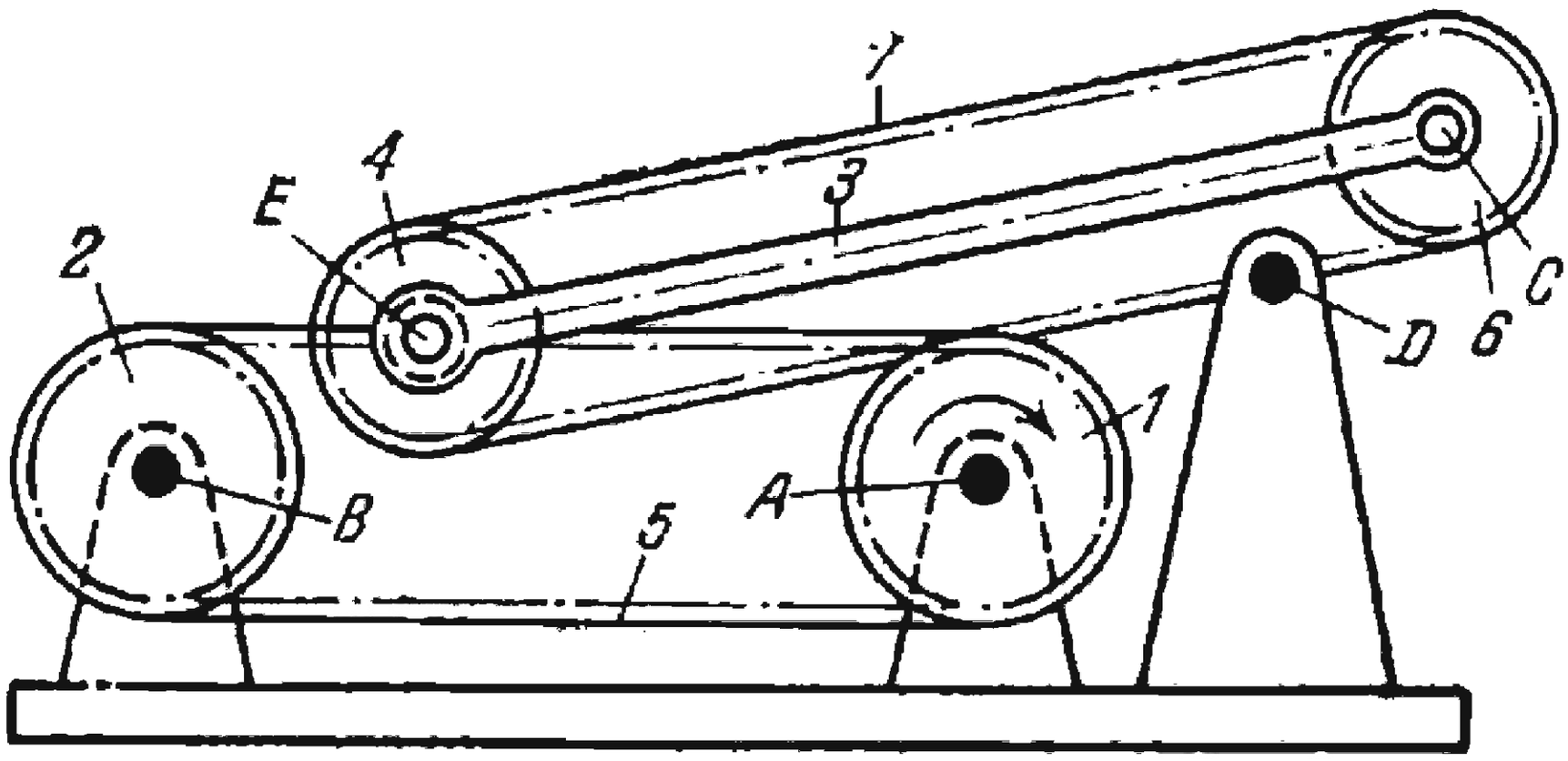
Flexible link *1* runs over pulleys *4* and *7*, of equal diameter, and oscillates about fixed axis *A*. Link *5*, designed as a complex lever, is connected by turning pairs *G* and *C* to pulleys *4* and *7* and by turning pairs *D* and *E* to link *2* and to link *6* which turns about fixed axis *B*. Link *3* turns about axis *A* and is connected by turning pair *F* to link *2*. When flexible link *1* turns about axis *A*, links *2* and *5* have complex motions and links *3* and *6* oscillate about axes *A* and *B*.

2013	HAIN LINKWORK DOUBLE TILTING CRAWLER MECHANISM	FL TC



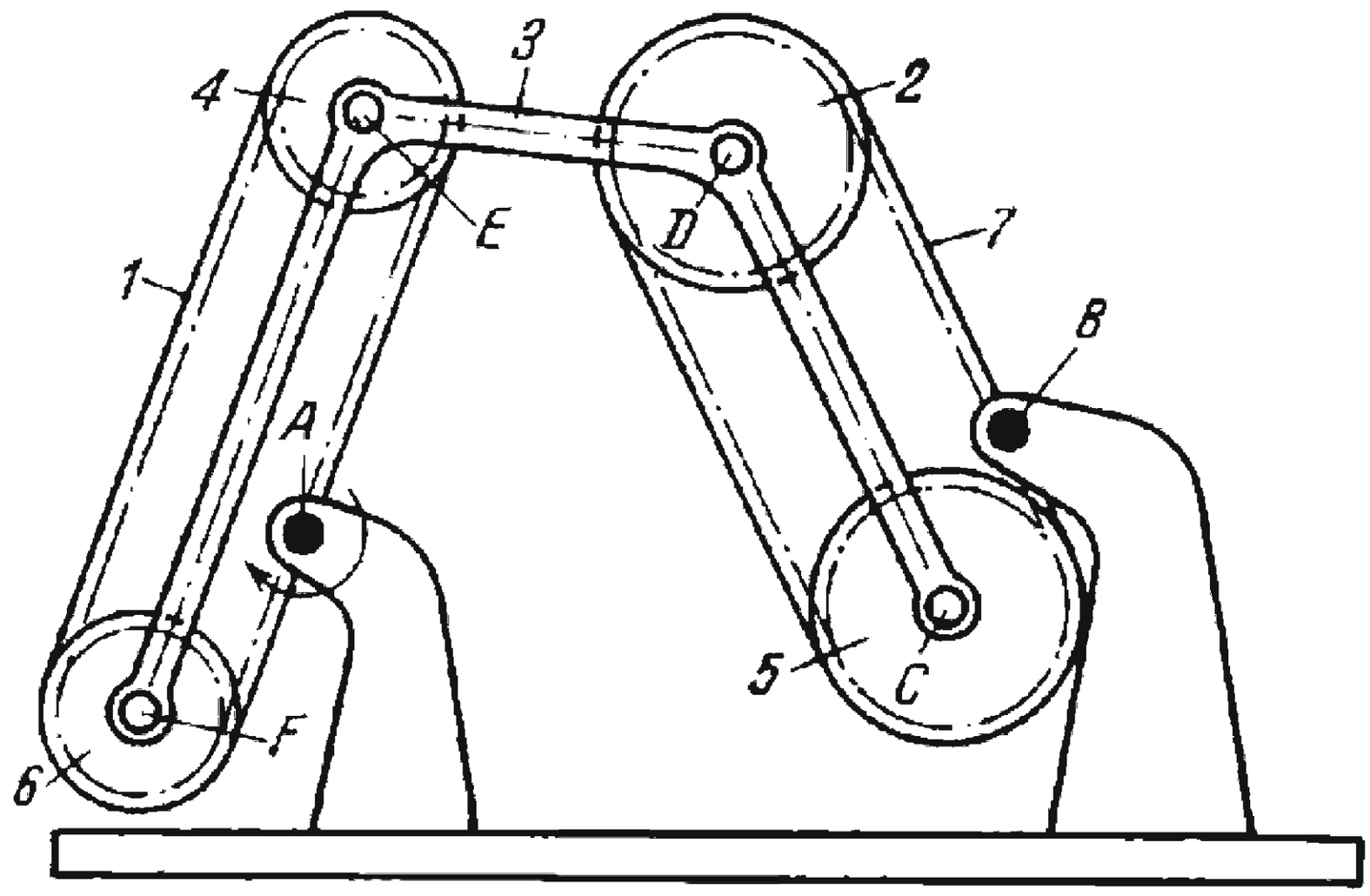
Pulleys *2* and *3* are of equal diameter, as are pulleys *4* and *5*. Link *1*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to pulleys *2*, *4*, *3* and *5*. Flexible link *6* runs over pulleys *2* and *3* and oscillates about fixed axis *A*. Flexible link *7* runs over pulleys *4* and *5* and oscillates about fixed axis *B*. When flexible link *6* turns about axis *A*, pulleys *2*, *3*, *4* and *5* roll along flexible links *6* and *7*, imparting a complex motion to link *1*.

2014	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



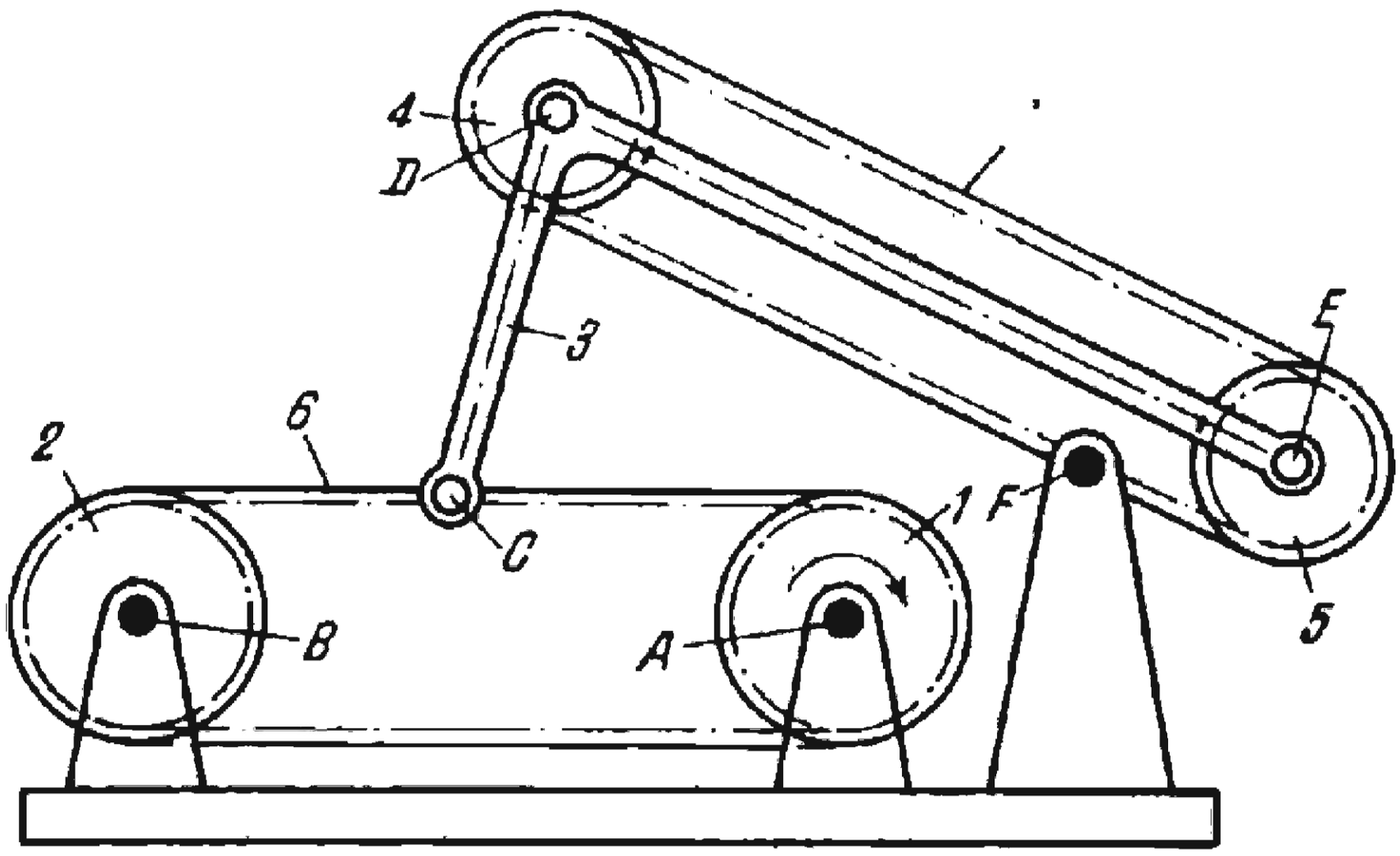
Pulleys *1* and *2* are of equal diameter, as are pulleys *4* and *6*. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* about fixed axis *B*. Flexible link *5* is connected by turning pair *E* to pulley *4*. Link *3* is connected by turning pairs *E* and *C* to pulleys *4* and *6*. Flexible link *7* runs over pulleys *4* and *6* and oscillates about fixed axis *D*. When pulley *1* rotates about axis *A*, pulleys *4* and *6* roll along flexible link *7*, imparting complex motion to link *3*.

2015	HAIN LINKWORK DOUBLE TILTING CRAWLER MECHANISM	FL TC



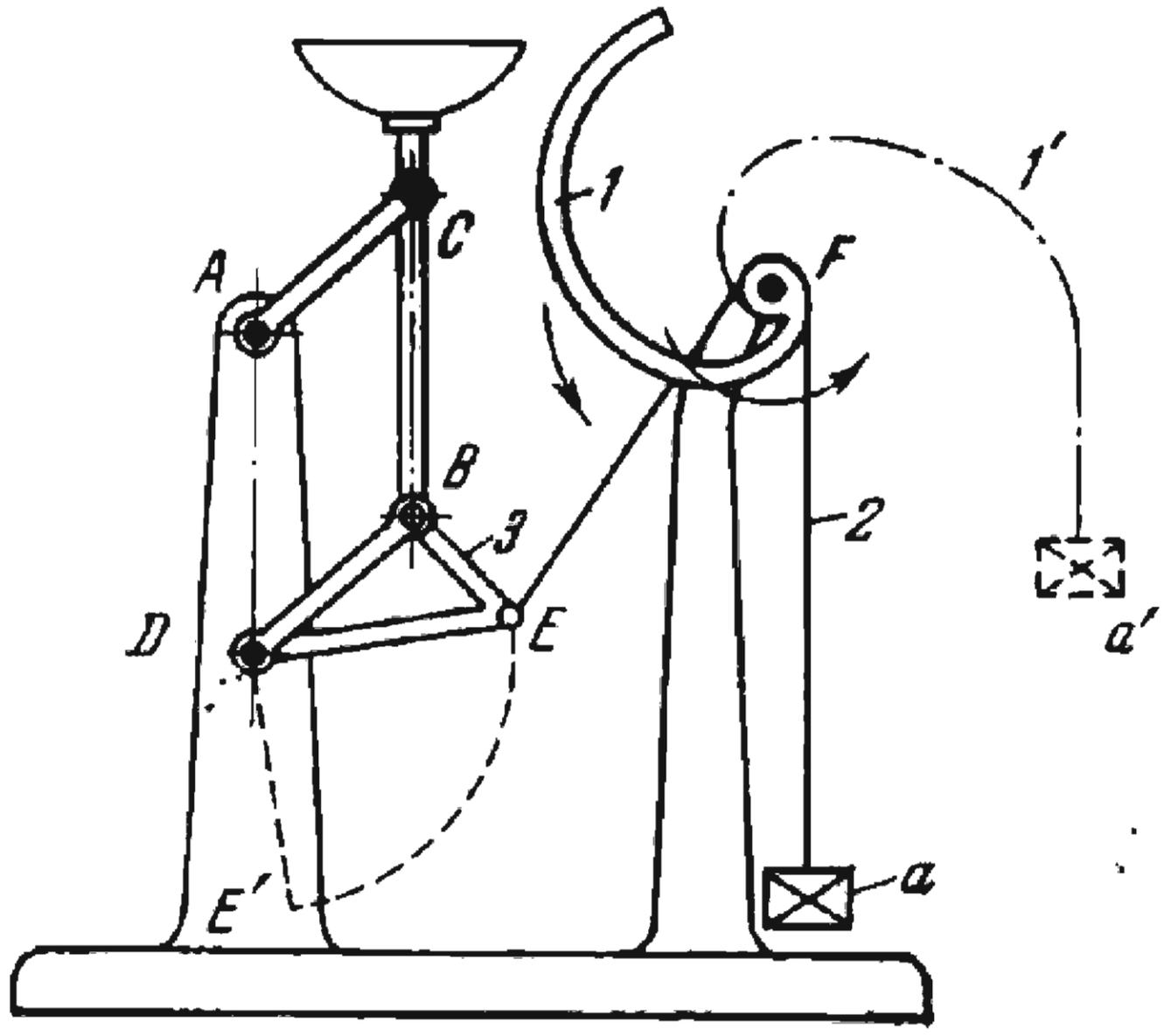
Pulleys *4* and *6* are of equal diameter, as are pulleys *2* and *5*. Flexible link *1* runs over pulleys *4* and *6* and oscillates about fixed axis *A*. Flexible link *7* runs over pulleys *2* and *5* and oscillates about fixed axis *B*. Link *3*, designed as a complex lever, is connected by turning pairs *F*, *E*, *D* and *C* to pulleys *6*, *4*, *2* and *5*. When flexible link *1* turns about axis *A*, pulleys *6*, *4*, *2* and *5* roll along flexible links *1* and *7*, imparting a complex motion to link *3*.

2016	HAIN LINKWORK TILTING CRAWLER MECHANISM	FL TC



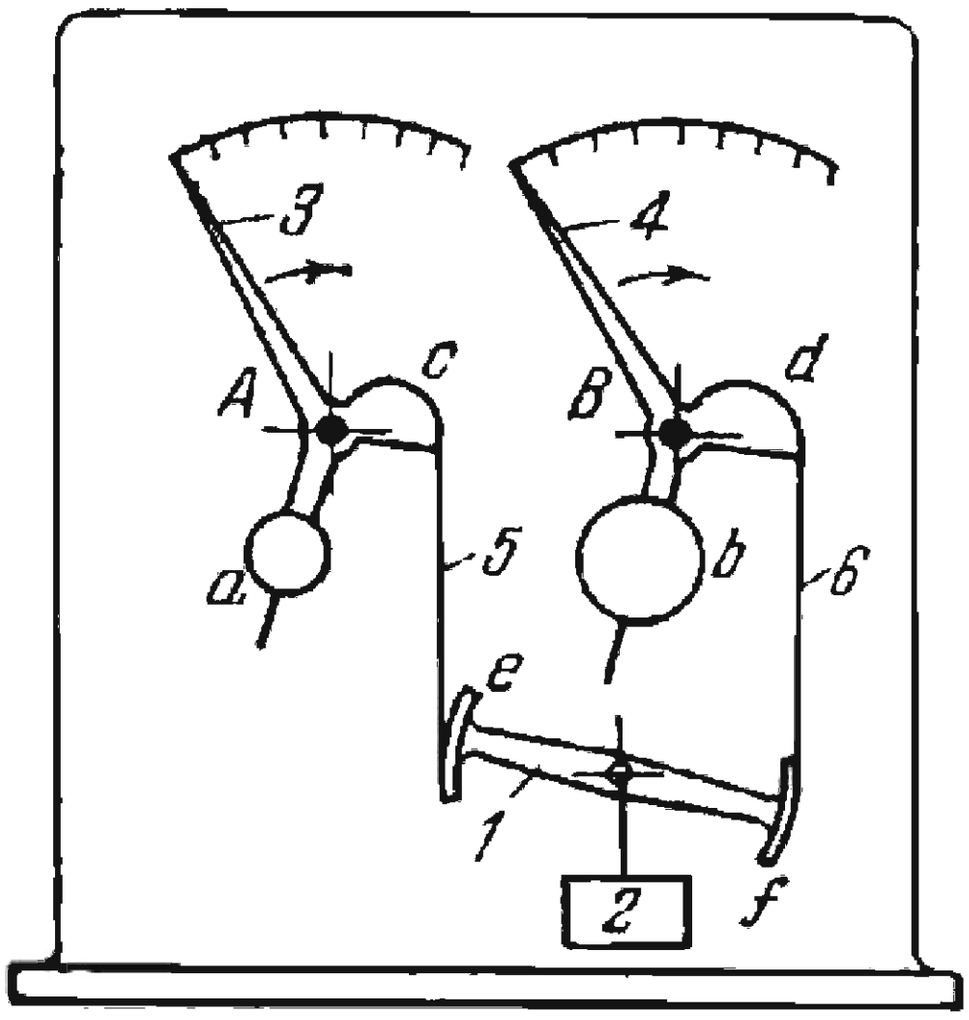
Pulleys *1* and *2* are of equal diameter, as are pulleys *4* and *5*. Pulley *1* rotates about fixed axis *A* and, through flexible link *6*, rotates pulley *2* about fixed axis *B*. Link *3*, designed as a bent lever, is connected by turning pair *C* to flexible link *6* and by turning pairs *D* and *E* to pulleys *4* and *5*. Flexible link *7* runs over pulleys *4* and *5* and oscillates about fixed axis *F*. When pulley *1* rotates about axis *A*, pulleys *4* and *5* roll along flexible link *7*, imparing a complex motion to link *3*.

2017	LINKWORK FLEXIBLE-LINK MECHANISM OF A PAN-TYPE BALANCE	FL B



The lengths of the links comply with the conditions: $\overline{AC} = \overline{DB}$ and $\overline{AD} = \overline{CB}$. Flexible link 2, secured at point E to link 3, runs over link 1. Link 1 is of special shape, enabling weighing to be performed with a single constant weight a. When, in weighing, point E of link 3 turns about fixed axis D to position E', link 1 turns about fixed axis F to position $1'$ and weight a is moved to position a'.

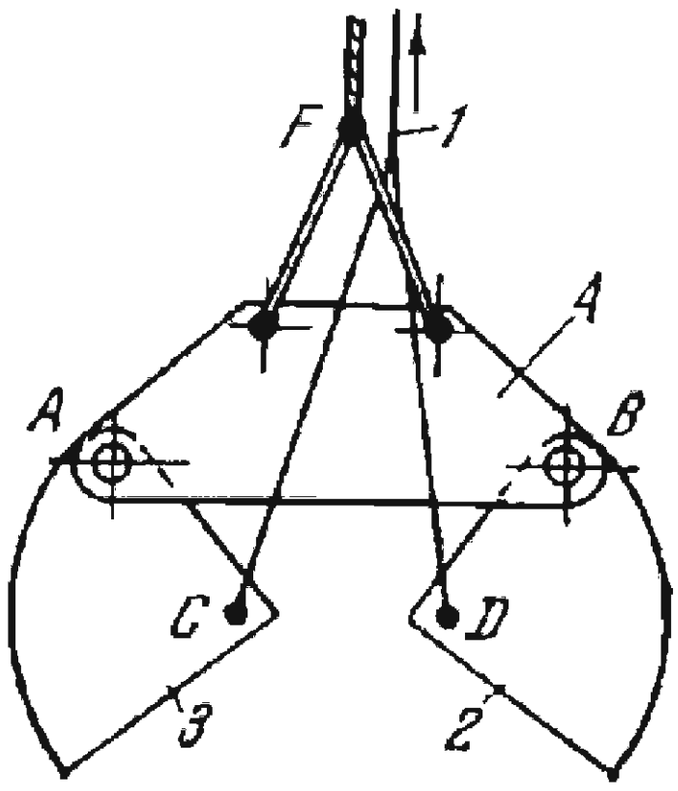
2018	FLEXIBLE-LINK BEAM BALANCE	FL B



Beam *3* with a hand and weight *a* turns about fixed axis *A*. Beam *4* with a hand and a heavier weight *b* turns about fixed axis *B*. Flexible links *5* and *6* run over shaped lugs *c* and *d* of beams *3* and *4*. The other ends of the flexible links are secured to the shaped ends *e* and *f* of freely suspended link *1*. Item *2* to be weighed is suspended from the middle of link *1*. Until the weight of load *2* reaches a definite value, only beam *3* turns about axis *A*. When the load exceeds a certain limit, beam *4* also begins to turn about axis *B*.

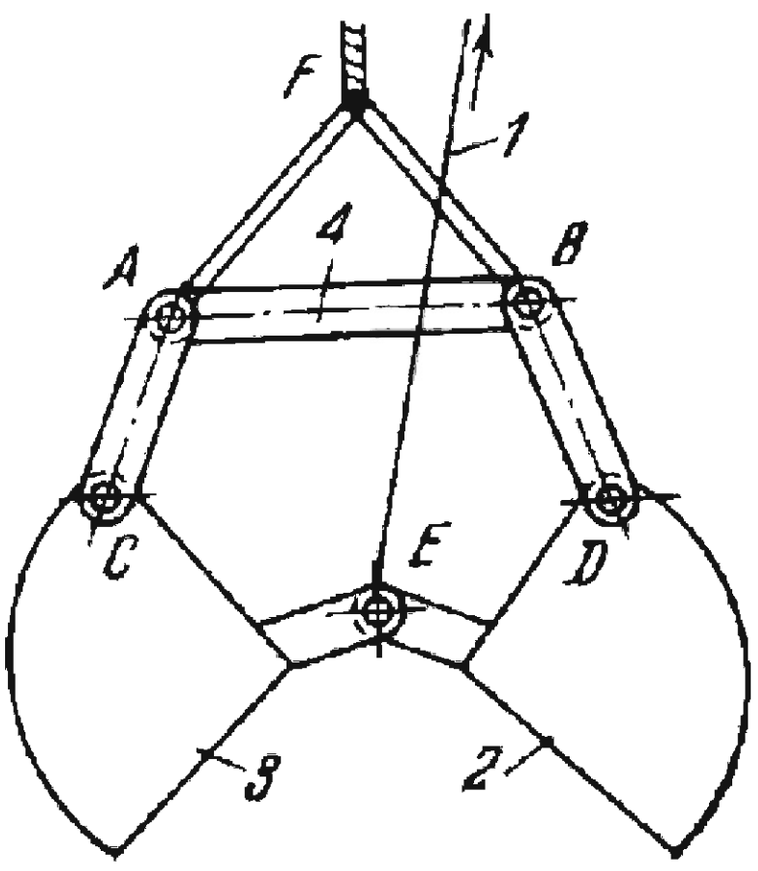
12. MECHANISMS OF MATERIALS HANDLING EQUIPMENT (2019 through 2024)

2019	LINKWORK CLAMSHELL BUCKET MECHANISM WITH A FLEXIBLE LINK	FL MH

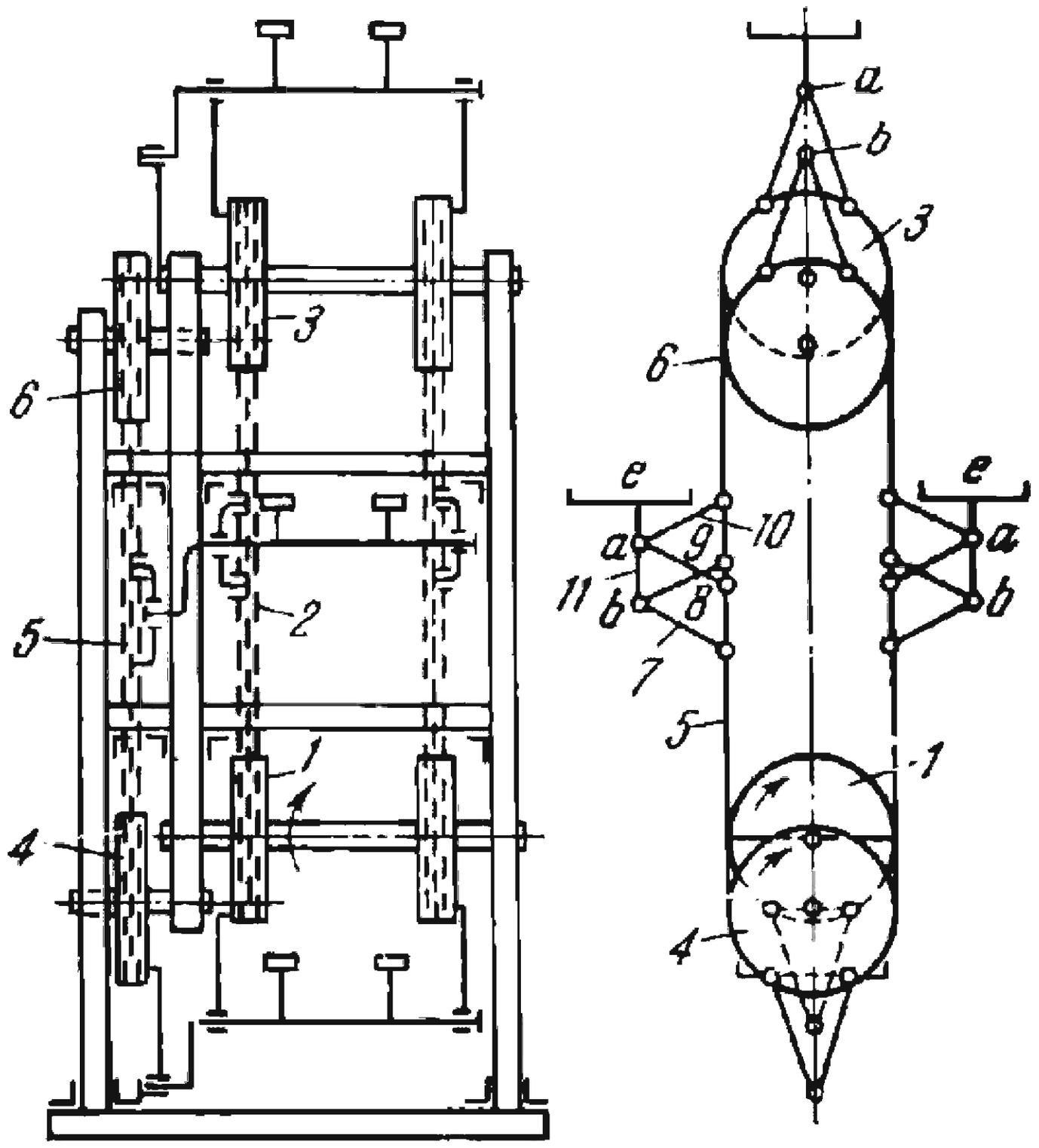


Scoops *3* and *2* of the bucket are pivoted at points *A* and *B*, symmetrically located on head *4* which is suspended from the holding rope at point *F*. Two ends of flexible link *1*, the closing rope, are attached to the scoops at points *C* and *D*. When closing rope *1* is pulled upward, scoops *2* and *3* are brought together, closing the bucket with the load.

2020	LINKWORK CLAMSHELL BUCKET MECHANISM WITH A FLEXIBLE LINK	FL MH

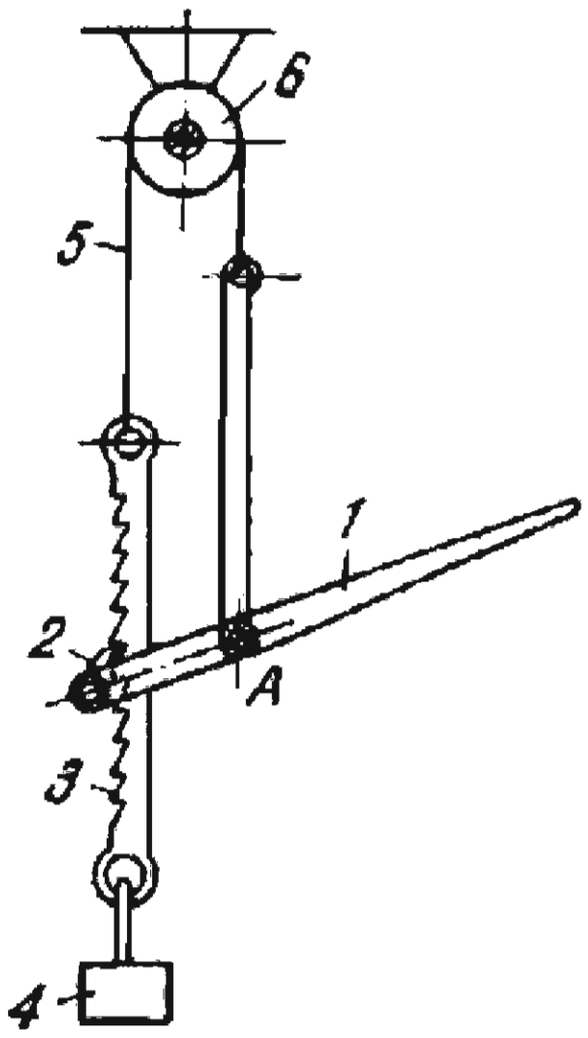


The lengths of the links comply with the conditions: $\overline{AC} = \overline{BD}$ and $\overline{CE} = \overline{ED}$. Scoops *3* and *2* of the bucket are pivoted at points *C* and *D*. Link *4*, the bucket head, is suspended from the holding rope at point *F*. Flexible link *1*, the closing rope, is attached to the scoops at point *E*, a turning pair between the scoops. When closing rope *1* is pulled upward, scoops *2* and *3* are brought together, closing the bucket with the load.



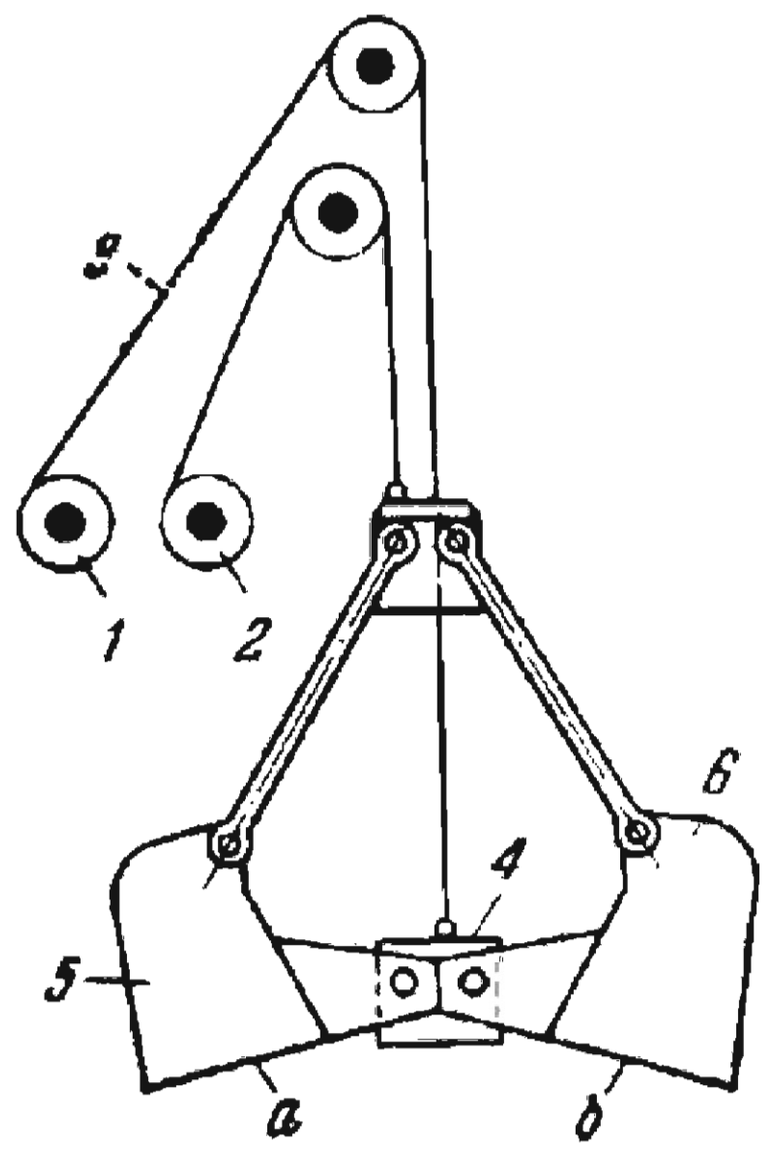
Flexible link *2*, designed as a chain, runs over chain sprockets *1* and *3*. Flexible link *5*, another chain, runs over sprockets *4* and *6*. Attached to one chain are links *7* and *8* and to the other, links *9* and *10*. These links are connected by turning pairs *a* and *b* to link *11*. The lengths of all these links are designed so that points *a* and *b* always lie on a vertical line. Then, as the chains move over the sprockets, platforms *e*, perpendicular to links *11* and intended for holding the boards, will always be horizontal. Thus, as the chains go around the sprockets, the figure formed by links *7*, *8*, *9*, *10* and *11* changes but points *a* and *b* remain on a vertical line and platforms *e*, carrying boards, remain horizontal. Sprockets *1* and *4* are the driving members and have a common drive.

2022	LEVER-RATCHET RACK-TYPE HOISTING MECHANISM WITH A FLEXIBLE LINK	FL MH



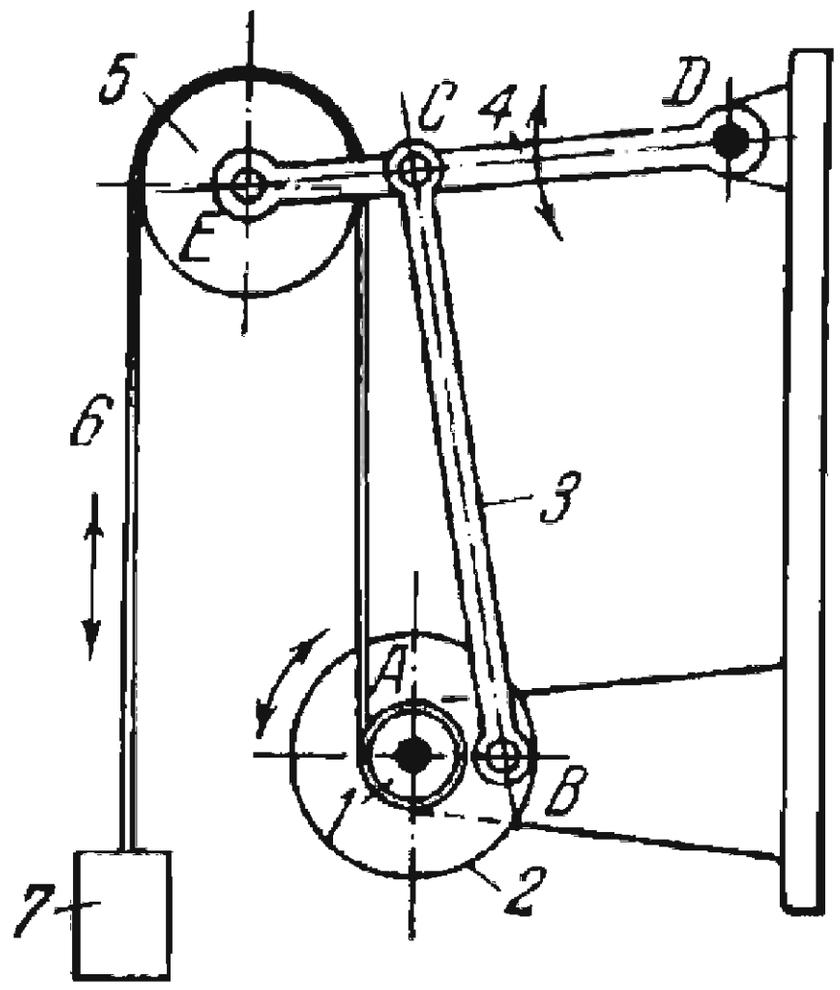
Ratchet-tooth rack *3* is suspended from flexible link *5* which runs over pulley *6*. When lever *1* is oscillated about axis *A*, pawl *2*, pivoted at the end of lever *1*, engages ratchet-tooth rack *3*, raising it with load *4*. The load does not descend when lever *1* is raised because it is held by a locking pawl or brake (not shown).

2023	LINKWORK TWO-ROPE CLAMSHELL BUCKET MECHANISM	FL MH



In lowering the bucket, drums *1* and *2* rotate clockwise, in which case the bucket will be open. To close the bucket, drum *1* rotates counterclockwise and drum *2* is stationary. This tensions rope *3* and closing member *4* moves upward, scoops *5* and *6* of the bucket dig into the material, closing until their cutting lips *a* and *b* meet in tight contact. In hoisting the load, both drums, *1* and *2*, rotate counterclockwise. To dump the load, drum *2* is braked and drum *1* turns clockwise. Then scoops *5* and *6* open due to gravity and the material is dumped.

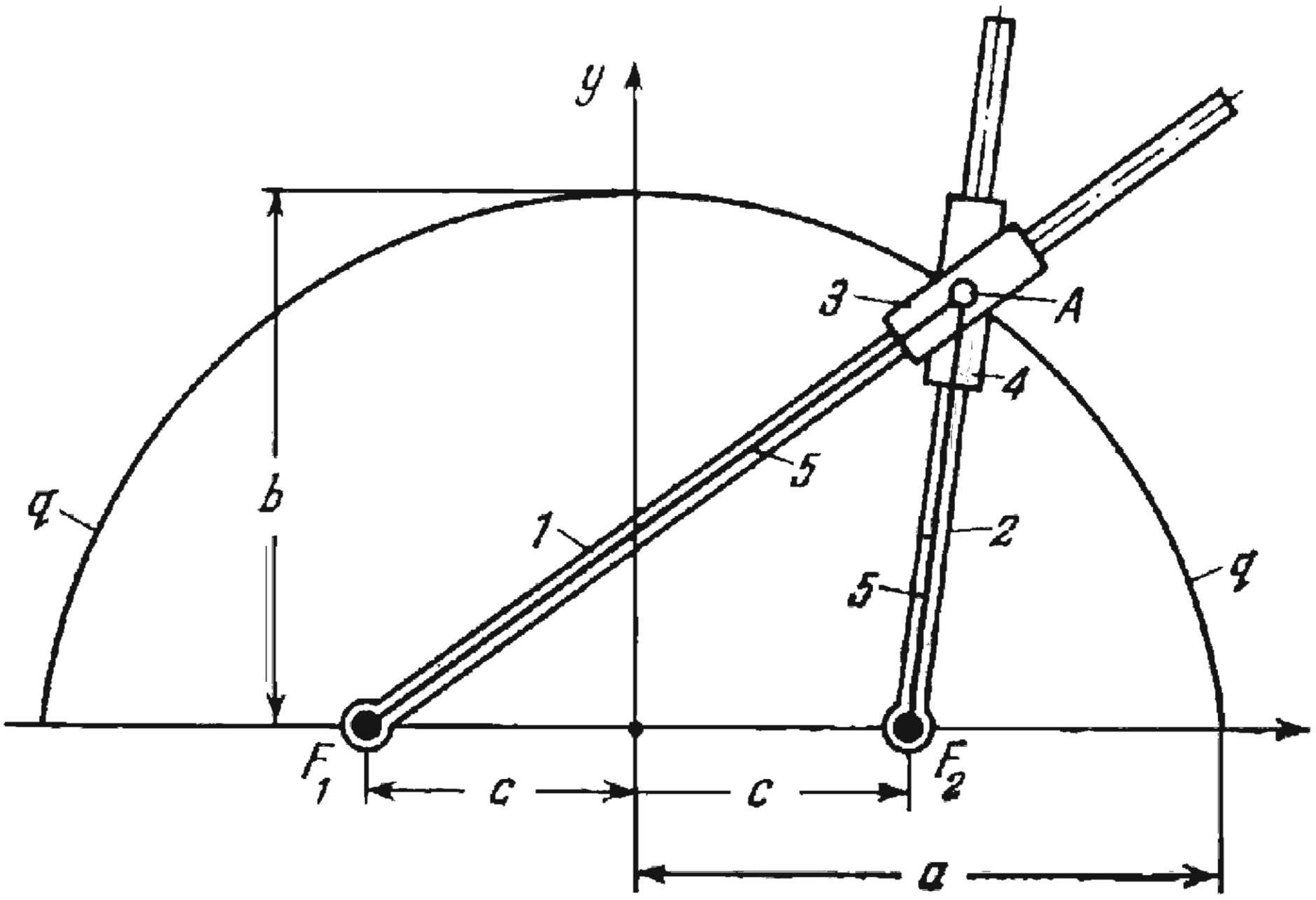
2024	LINKWORK FLEXIBLE-LINK MECHANISM FOR HOISTING AND LOWERING LOADS	FL MH



Drum *1* is rigidly attached to crank *2* of four-bar linkage *ABCD*. Flexible link *6*, wound on drum *1*, runs over pulley *5* which rotates freely about axis *E*. When crank *2* is rotated counter-clockwise or clockwise about fixed axis *A*, load *7* is raised or lowered, and a supplementary vertical reciprocating motion is imparted to the load by the oscillation of rocker arm *4* about fixed axis *D*.

13. MECHANISMS FOR GENERATING CURVES (2025, 2026 and 2027)

2025	LINK-GEAR FLEXIBLE-LINK MECHANISM FOR TRACING ELLIPSES	FL Ge

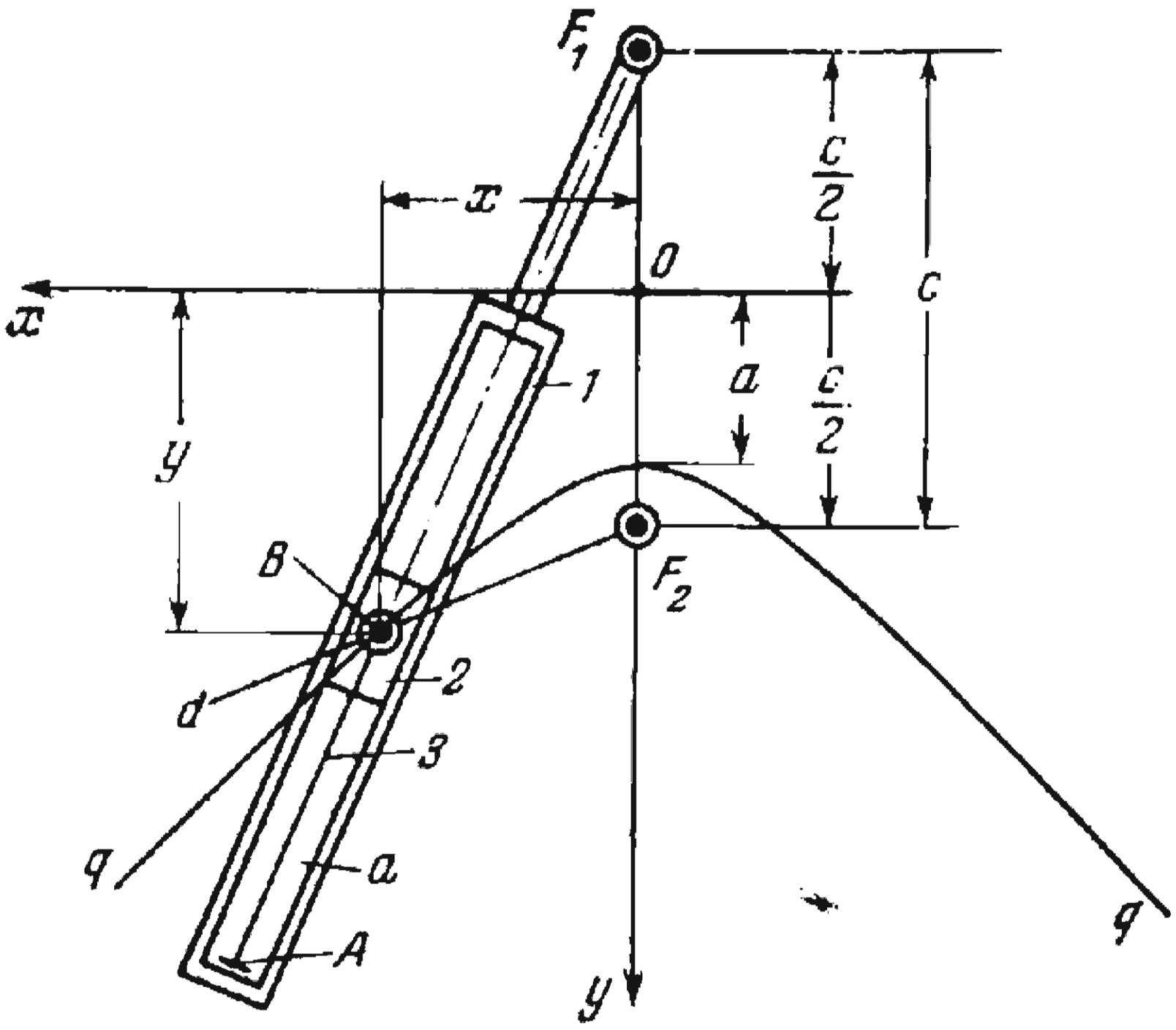


Link *1* rotates about fixed axis F_1 and is connected by a sliding pair to slider *3*. Link *2* rotates about fixed axis F_2 and is connected by a sliding pair to slider *4*. Flexible cord *5* is attached at points F_1 and F_2 and passes through an eye in pivot *A*, the turning pair connecting sliders *3* and *4*. When link *1* rotates about axis F_1, point *A* describes ellipse *q*-*q* with its foci at points F_1 and F_2 and with the equation

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

where a and b are the semiaxes of the ellipse. The length of cord b is equal to $l = 2a$. By varying the distance $c = \sqrt{a^2 - b^2}$ and the length l of cord *5*, ellipses of various types can be traced.

2026	LINK-GEAR FLEXIBLE-LINK MECHANISM FOR TRACING HYPERBOLAS	FL Ge

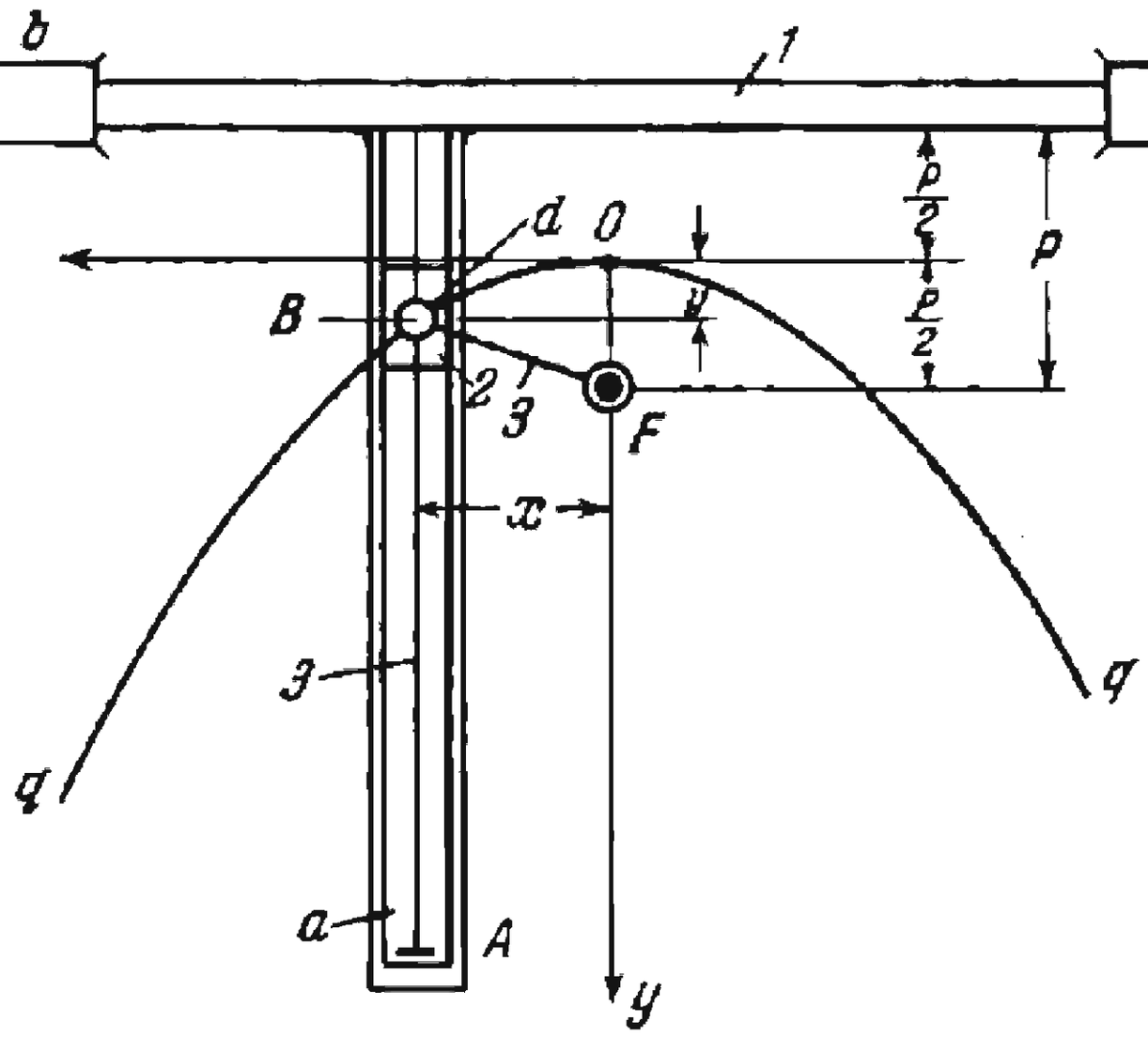


Link *1* turns about fixed axis F_1. Slider *2* moves along slot *a* of link *1*. Flexible cord *3* is attached at point *A* in slot *a* and passes through an eye in pin *d* of slider *2*, having its other end attached to fixed point F_2. When slider *2* moves along slot *a*, its point *B* describes hyperbola *q-q* with its foci at points F_1 and F_2 and with the equation

$$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$$

where $b = \sqrt{c^2 - a^2}$. By varying distances *a* and *c*, quadratic hyperbolas of various types can be traced.

2027	LINK-GEAR FLEXIBLE-LINK MECHANISM FOR TRACING PARABOLAS	FL Ge

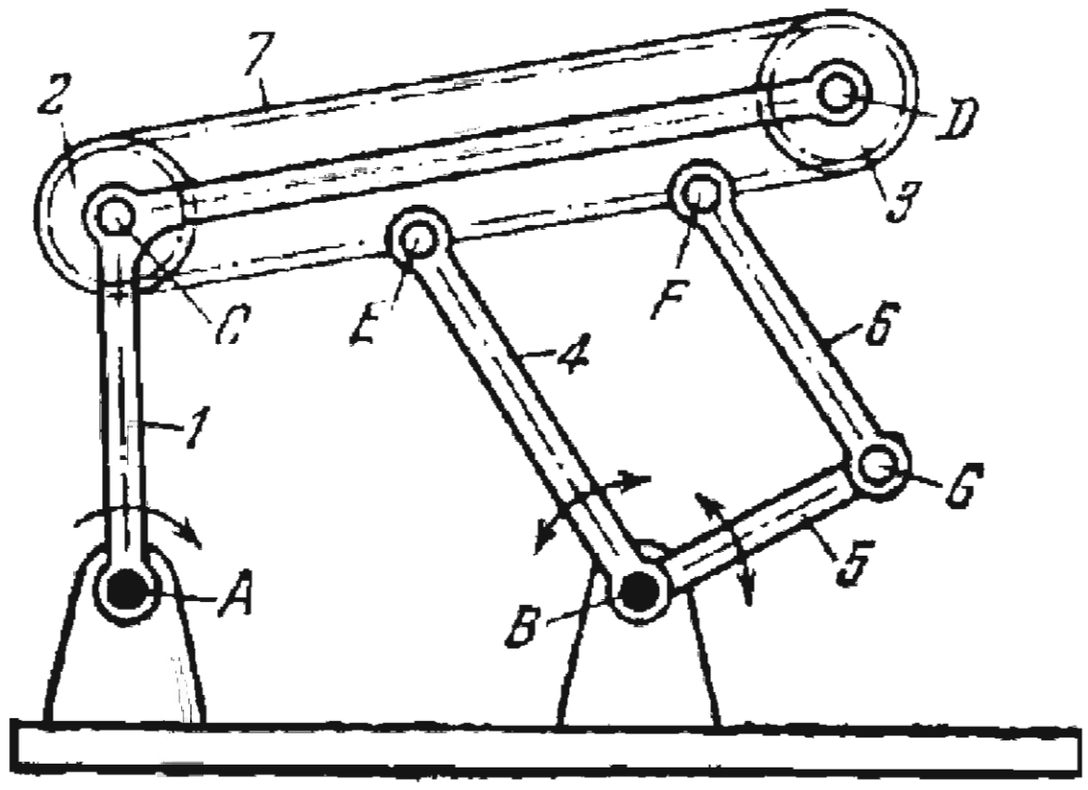


Link *1* slides in fixed guides *b*-*b*. Rigidly attached to link *1* is a slotted member whose slot *a* is perpendicular to the axis of guides *b*-*b*. Slider *2* moves along slot *a*. Flexible cord *3* is attached with one end at point *A* in slot *a*, then passes through an eye in pin *d* of slider *2* and has its other end attached to fixed point *F*. When slider *2* moves along slot *a*, point *B* of pin *d* describes parabola *q*-*q* with its focus at point *F* and with the equation

$$x^2 = 2py.$$

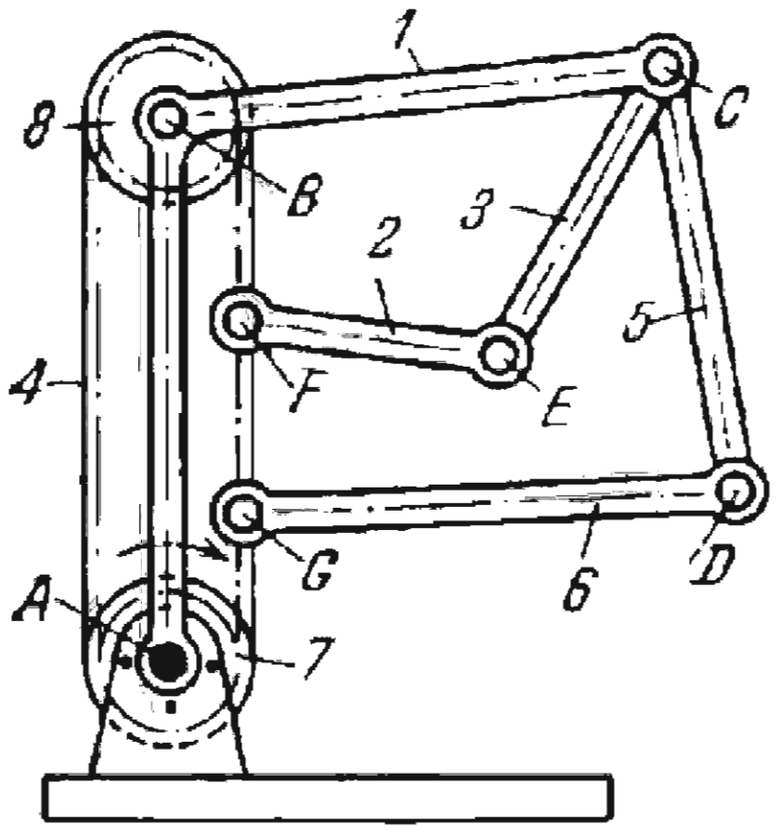
By varying distance *p*, quadratic parabolas of various types can be traced.

2028	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



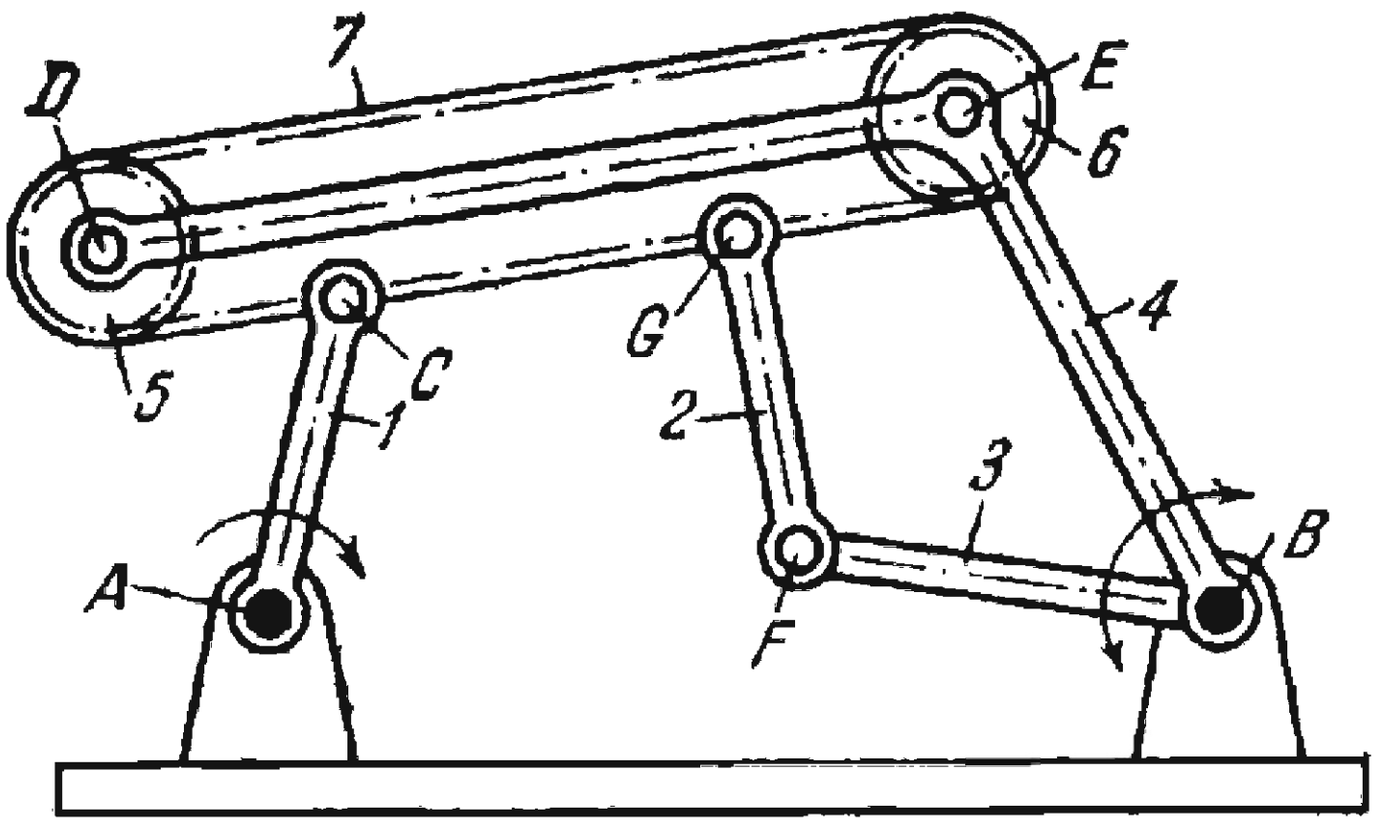
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *C* and *D* to pulleys *2* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *E* and *F* to links *4* and *6*. Links *4* and *5* turn about fixed axis *B*. Link *5* is connected by turning pair *G* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion and links *4* and *5* oscillate about axis *B*.

2029	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



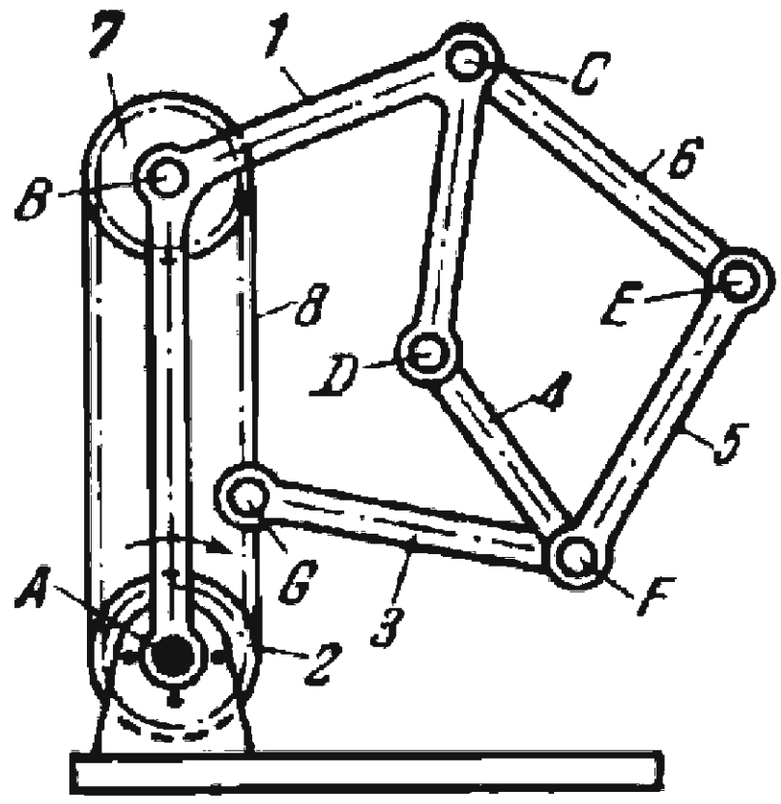
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *8* and to links *3* and *5*. Flexible link *4* runs over pulleys *7* and *8*, of equal diameter, and is connected by turning pairs *F* and *G* to links *2* and *6* which, in turn, are connected by turning pairs *E* and *D* to links *3* and *5*. Pulley *7* is rigidly attached to the base. When link *1* turns about axis *A*, links *2*, *3*, *5* and *6* have complex motions.

2030	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



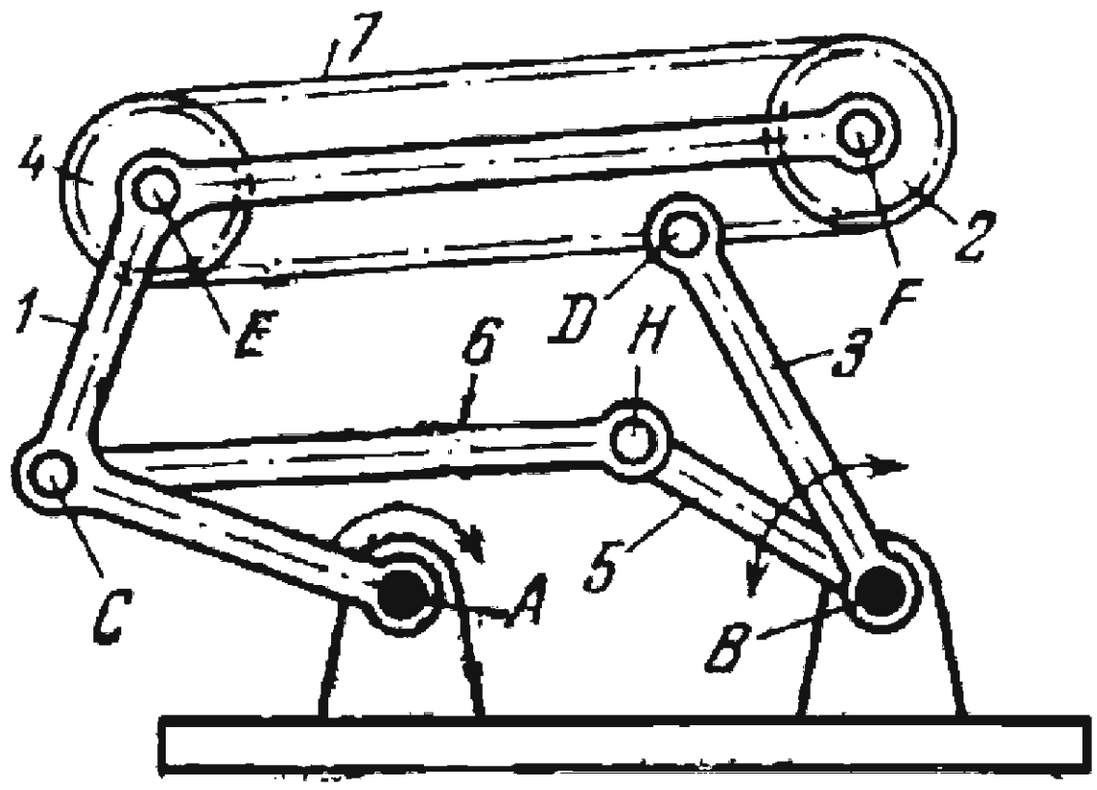
Link *4*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *D* and *E* to pulleys *5* and *6*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *C* and *G* to links *1* and *2*. Link *1* turns about fixed axis *A* and link *2* is connected by turning pair *F* to link *3* which turns about axis *B*. When link *1* turns about axis *A*, link *2* has a complex motion and links *3* and *4* oscillate about axis *B*.

2031	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



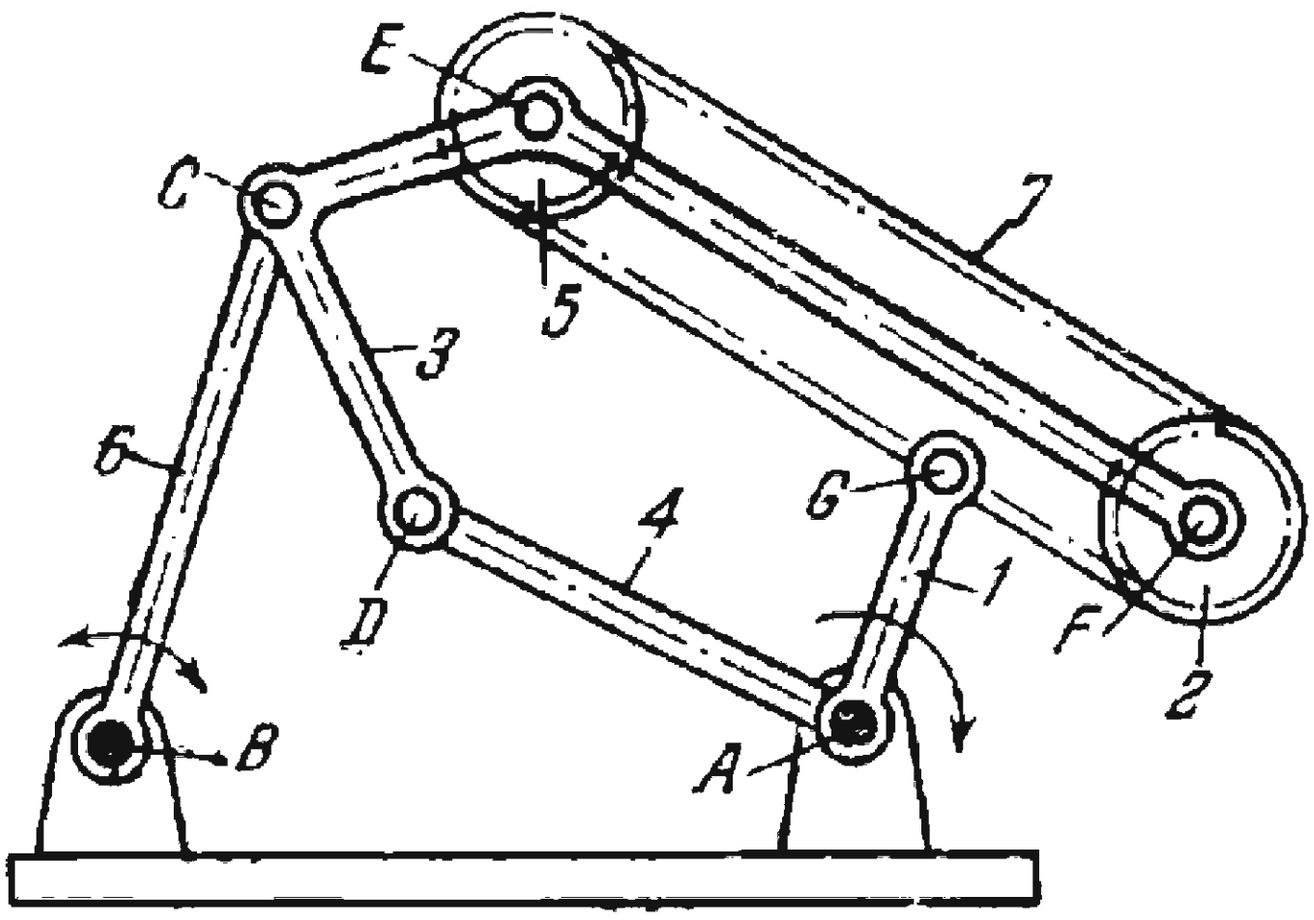
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *D* to pulley *7* and to links *6* and *4*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *G* to link *3*. Pulley *2* is rigidly attached to the base. Link *5* is connected by turning pairs *E* and *F* to link *6* and to links *4* and *3*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2032	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



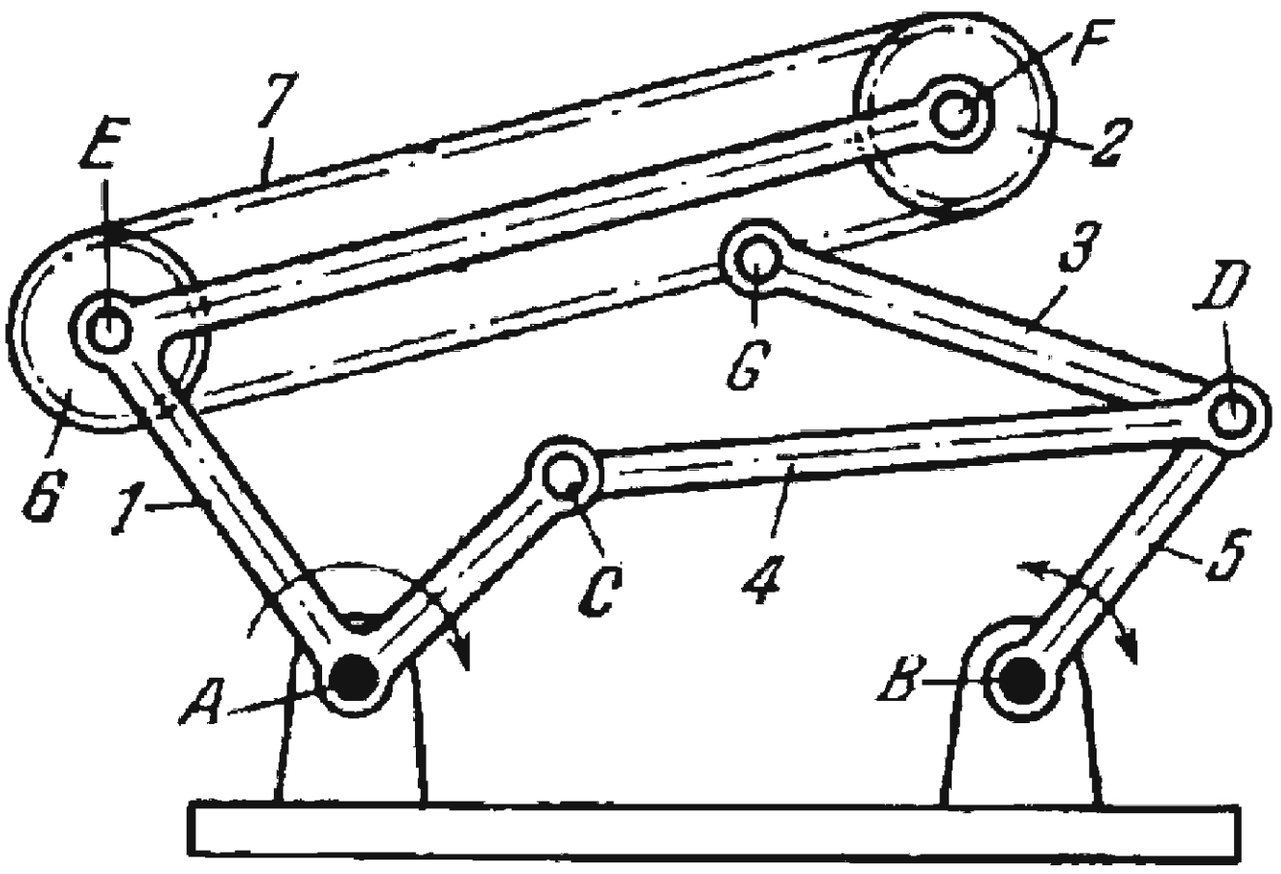
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *C*, *E* and *F* to link *6* and to pulleys *4* and *2*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *D* to link *3* which turns about fixed axis *B*. Link *5* turns about axis *B* and is connected by turning pair *H* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion and links *3* and *5* oscillate about axis *B*.

2033	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



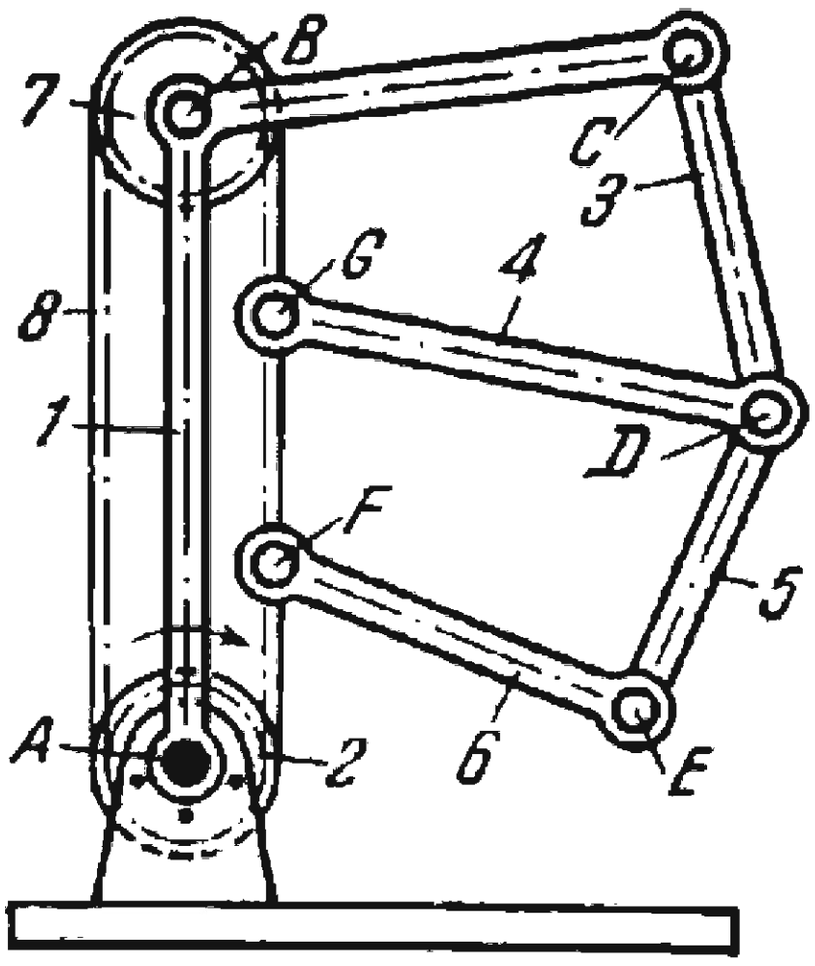
Link *3*, designed as a complex lever, is connected by turning pairs *F*, *E*, *C* and *D* to pulleys *2* and *5*, of equal diameter, and to links *6* and *4*. Flexible link *7* runs over the pulleys and is connected by turning pair *G* to link *1* which turns about fixed axis *A*. Links *6* and *4* turn about fixed axes *B* and *A*. When link *1* turns about axis *A*, link *3* has a complex motion and links *4* and *6* oscillate about axes *A* and *B*.

2034	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



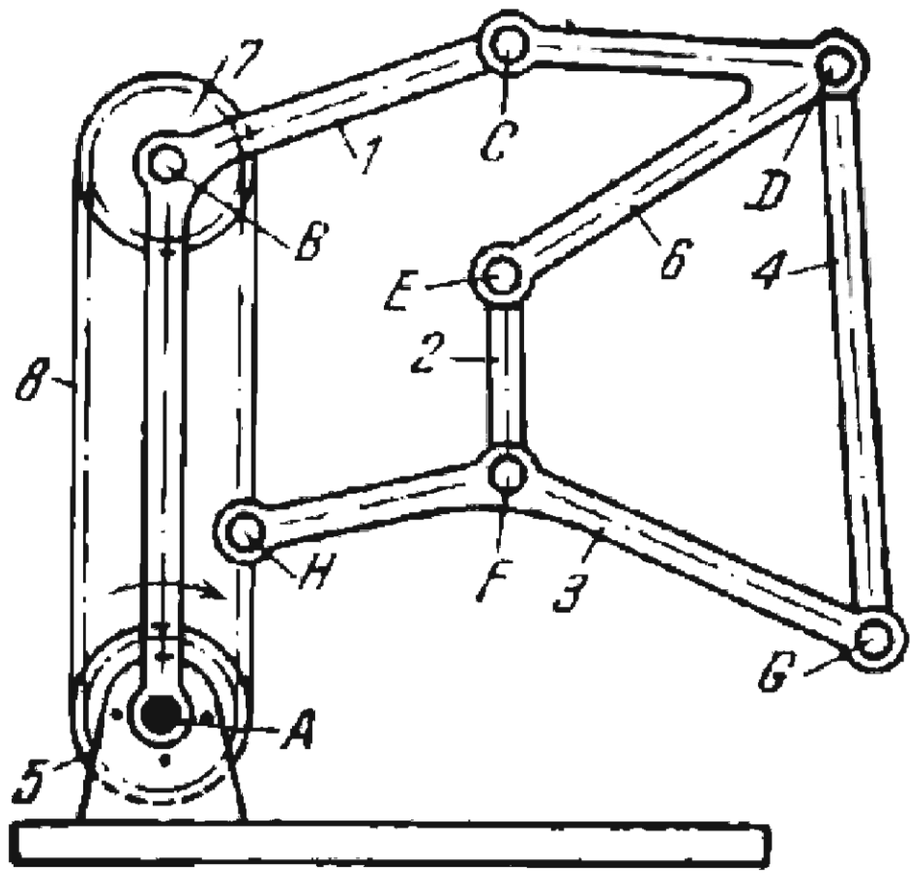
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *C*, *E* and *F* to link *4* and to pulleys *6* and *2*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *G* to link *3*. Link *5* turns about fixed axis *B* and is connected by turning pairs *D* to links *4* and *3*. When link *1* turns about axis *A*, links *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2035	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



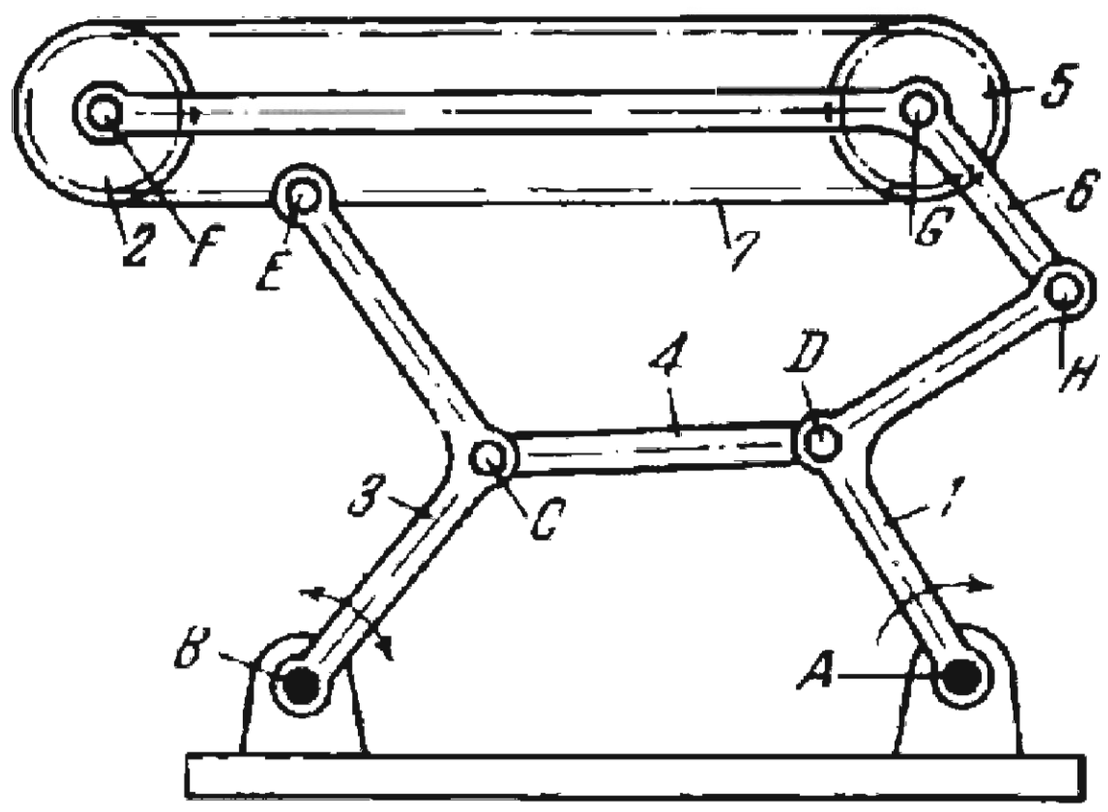
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and link *3*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pairs *F* and *G* to links *6* and *4*. Pulley *2* is rigidly attached to the base. Link *5* is connected by turning pairs *E* and *D* to link *6* and to links *4* and *3*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2036	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



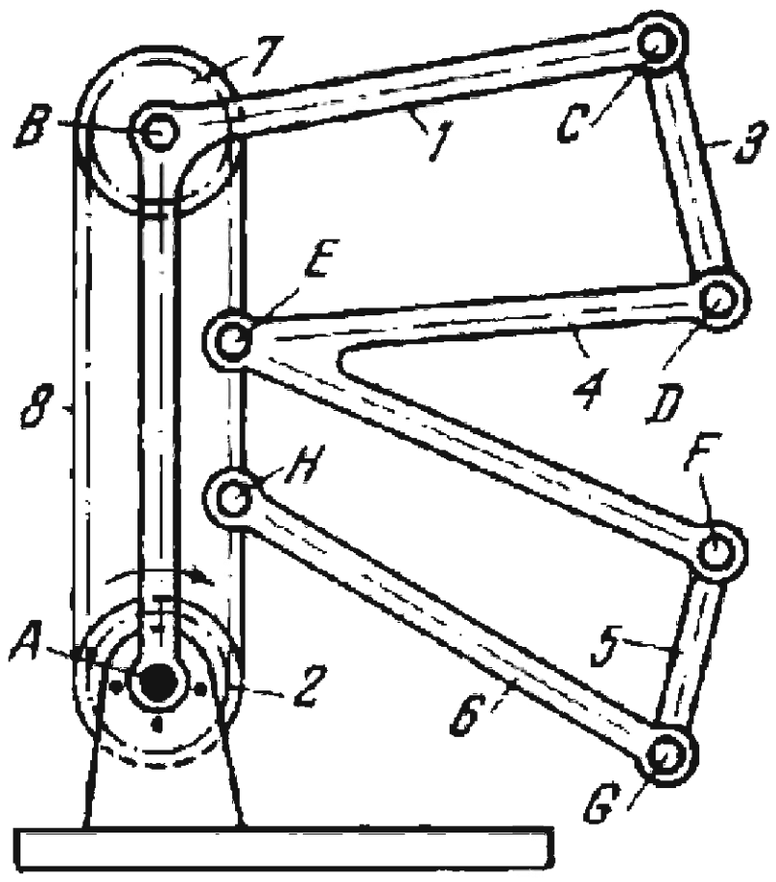
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and link *6*. Flexible link *8* runs over pulleys *5* and *7*, of equal diameter, and is connected by turning pair *H* to link *3*. Pulley *5* is rigidly attached to the base. Link *6*, designed as a bent lever, is connected by turning pairs *D* and *E* to links *4* and *2*. Link *3*, also designed as a bent lever, is connected by turning pairs *F* and *G* to links *2* and *4*. When link *1* turns about axis *A*, links *2*, *3*, *4* and *6* have complex motions.

2037	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	Fl. ¡Sa



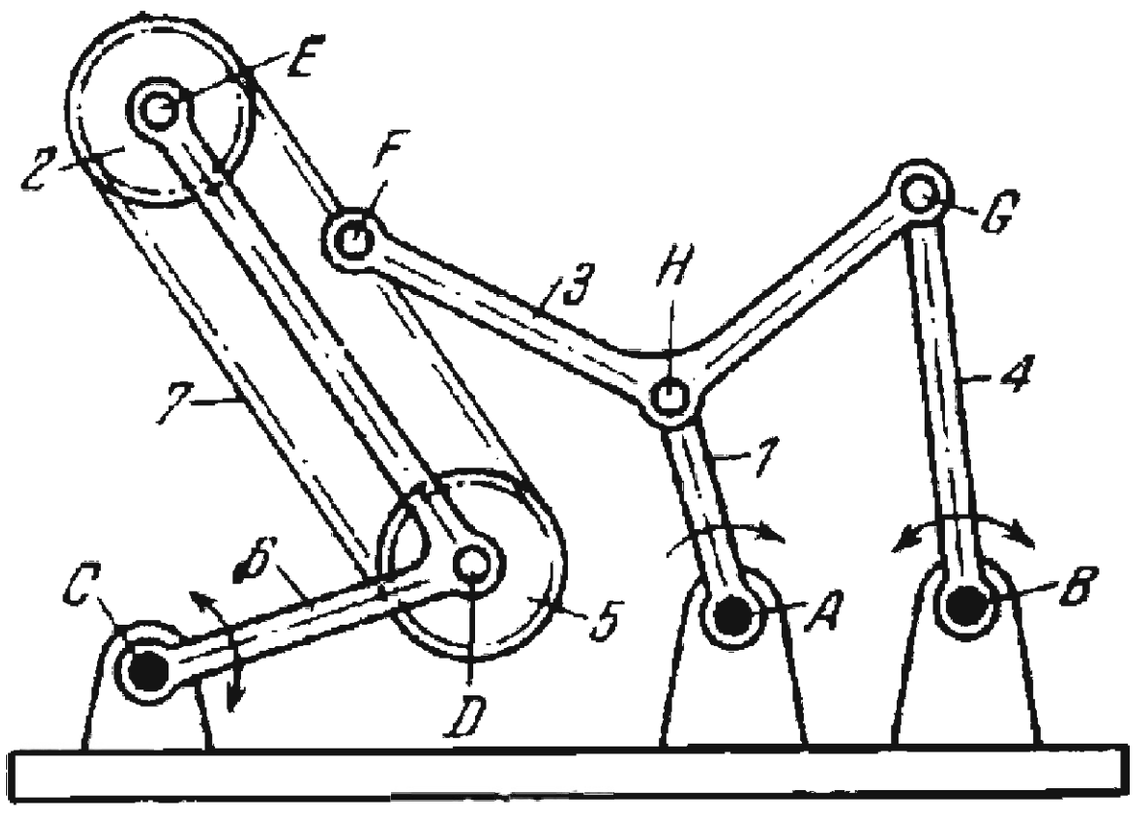
Link *6*, designed as a bent lever, is connected by turning pairs *F*, *G* and *H* to pulleys *2* and *5*, of equal diameter, and to link *1*. Flexible link *7* runs over the pulleys and is connected by turning pair *E* to link *3*. Links *1* and *3*, designed as bent levers, turn about fixed axes *A* and *B* and are connected by turning pairs *D* and *C* to link *4*. When link *1* turns about axis *A*, links *4* and *6* have complex motions and link *3* oscillates about axis *B*.

2038	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



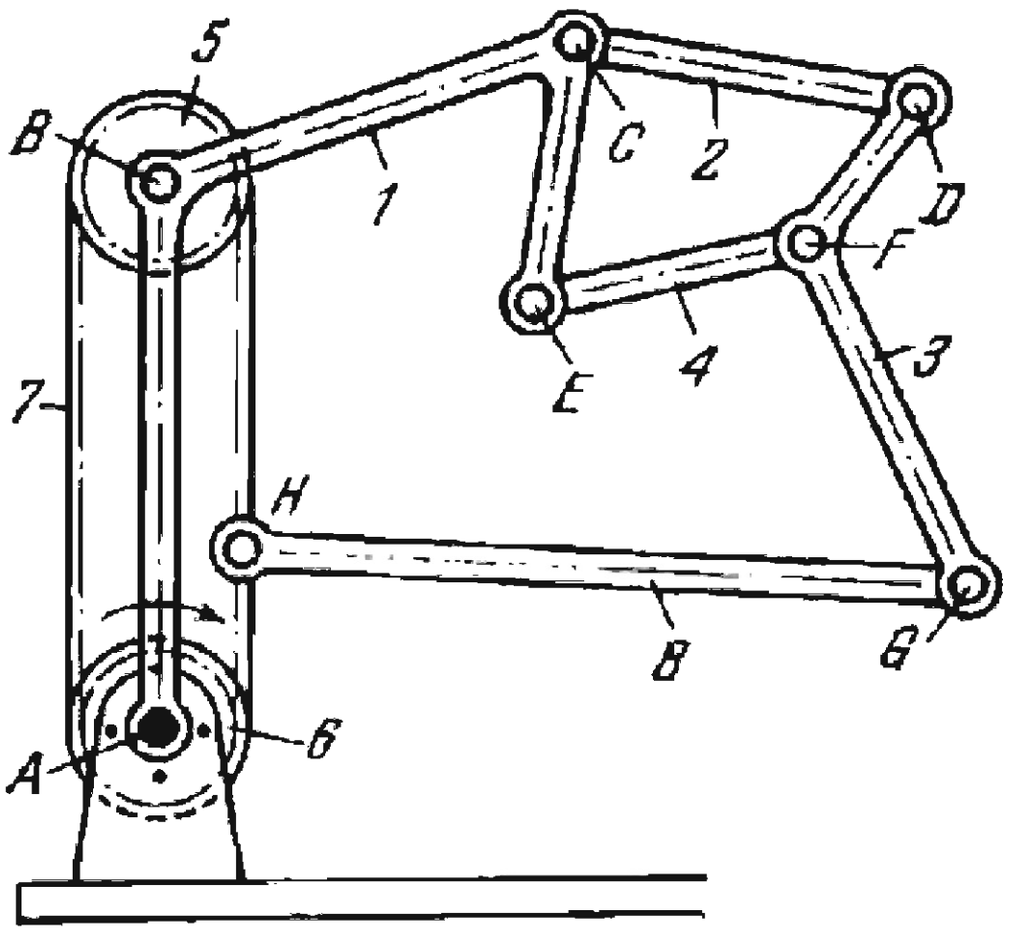
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and link *3*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pairs *E* and *H* to links *4* and *6*. Pulley *2* is rigidly attached to the base. Link *4*, designed as a bent lever, is connected by turning pairs *D* and *F* to links *3* and *5*. Link *5* is connected by turning pair *G* to link *6*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2039	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



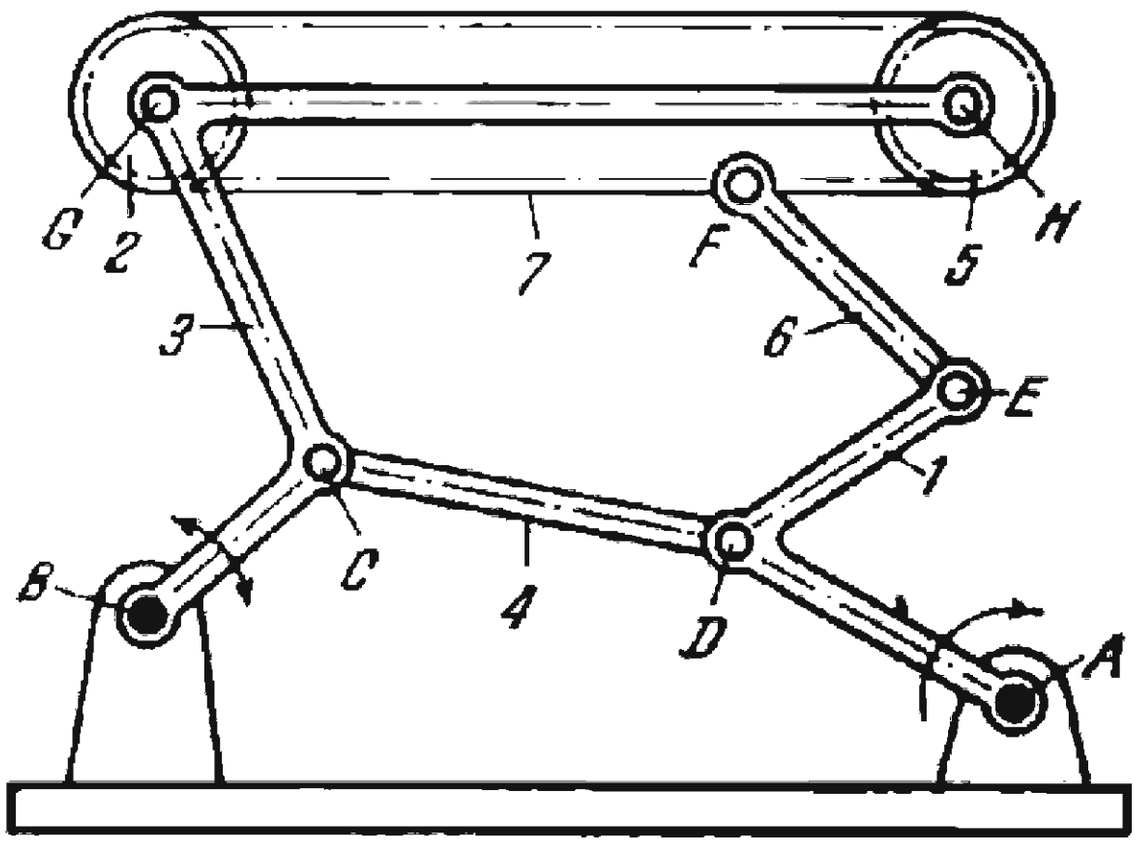
Link *6*, designed as a bent lever, turns about fixed axis *C* and is connected by turning pairs *D* and *E* to pulleys *5* and *2*, of equal diameter. Flexible link *7* runs over the pulleys, and is connected by turning pair *F* to link *3* which is designed as a bent lever. Links *1* and *4* turn about fixed axes *A* and *B* and are connected by turning pairs *H* and *G* to lever *3*. When lever *1* turns about axis *A*, link *3* has a complex motion and links *4* and *6* oscillate about axes *B* and *C*.

2040	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



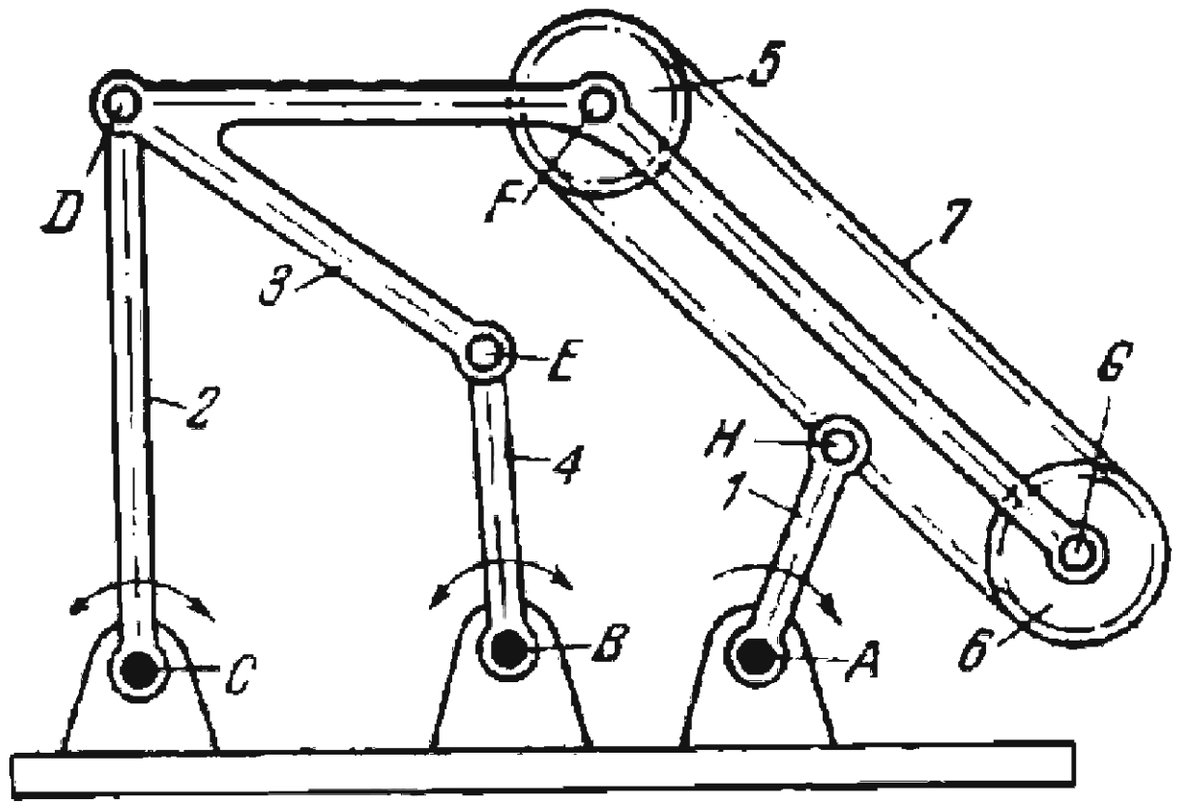
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *E* to pulley *5* and to links *2* and *4*. Flexible link *7* runs over pulleys *5* and *6*, of equal diameter, and is connected by turning pair *H* to link *8*. Pulley *6* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *D*, *F* and *G* to links *2*, *4* and *8*. When link *1* turns about axis *A*, links *2*, *3*, *4* and *8* have complex motions.

2041	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



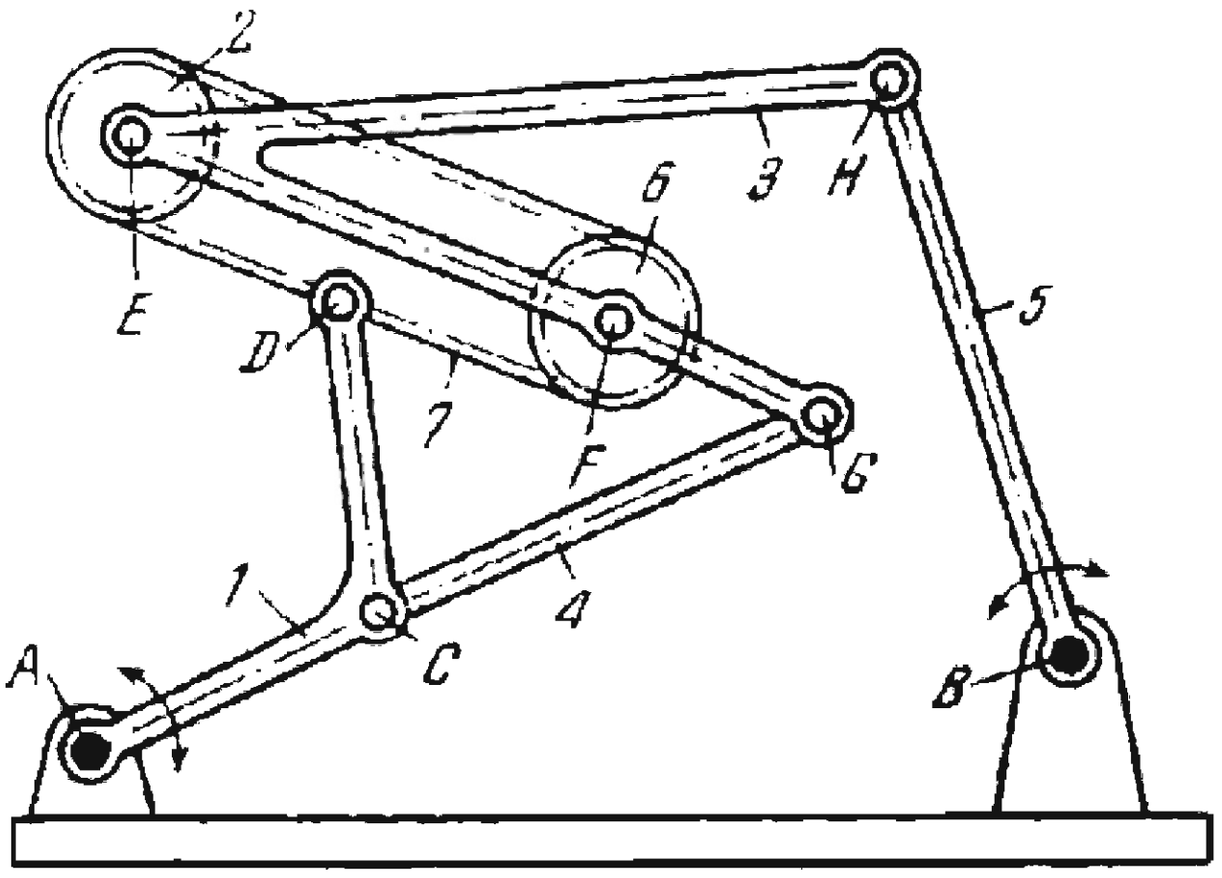
Link *3*, designed as a complex lever, turns about fixed axis *B* and is connected by turning pairs *C*, *G* and *H* to link *4* and to pulleys *2* and *5*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *F* to link *6*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *D* and *E* to links *4* and *6*. When link *1* turns about axis *A*, links *4* and *6* have complex motions and link *3* oscillates about axis *B*.

2042	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



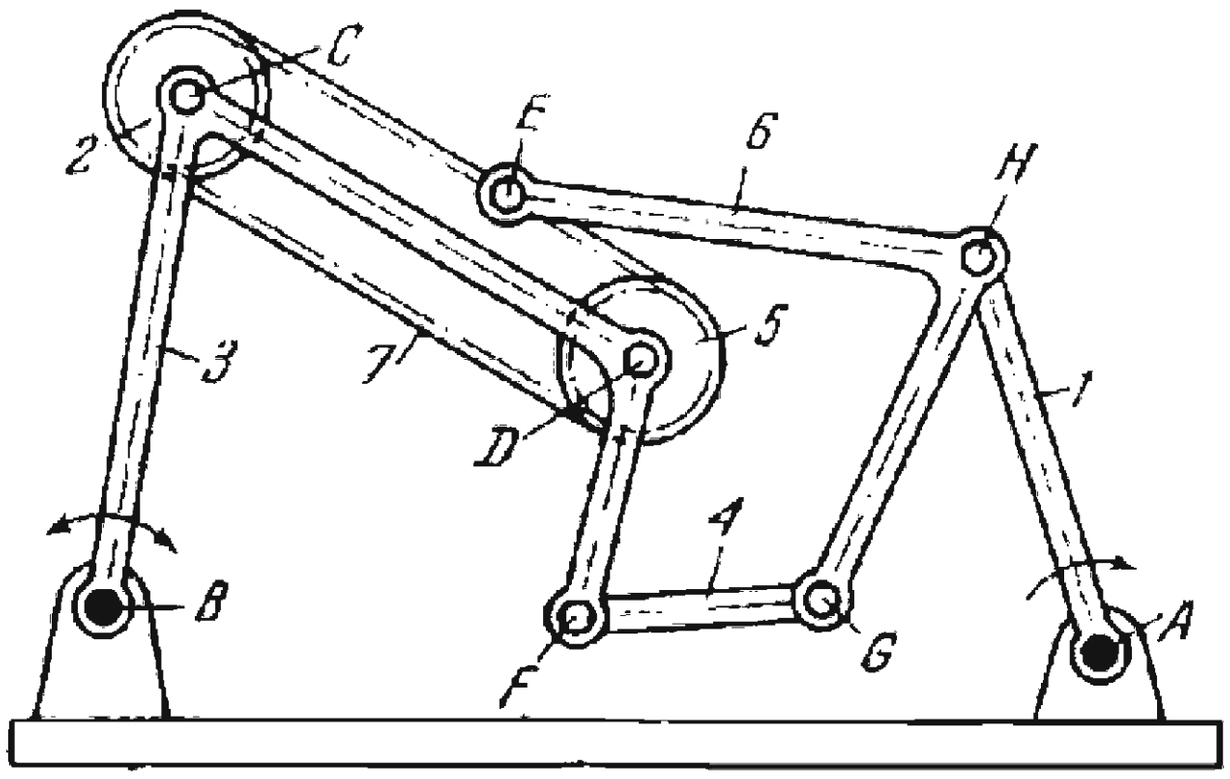
Link *3*, designed as a complex lever, is connected by turning pairs *E*, *D*, *F* and *G* to links *4* and *2* and to pulleys *5* and *6*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *H* to link *1*. Links *1*, *4* and *2* turn about fixed axes *A*, *B* and *C*. When link *1* turns about axis *A*, link *3* has a complex motion and links *2* and *4* oscillate about axes *C* and *B*.

2043	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



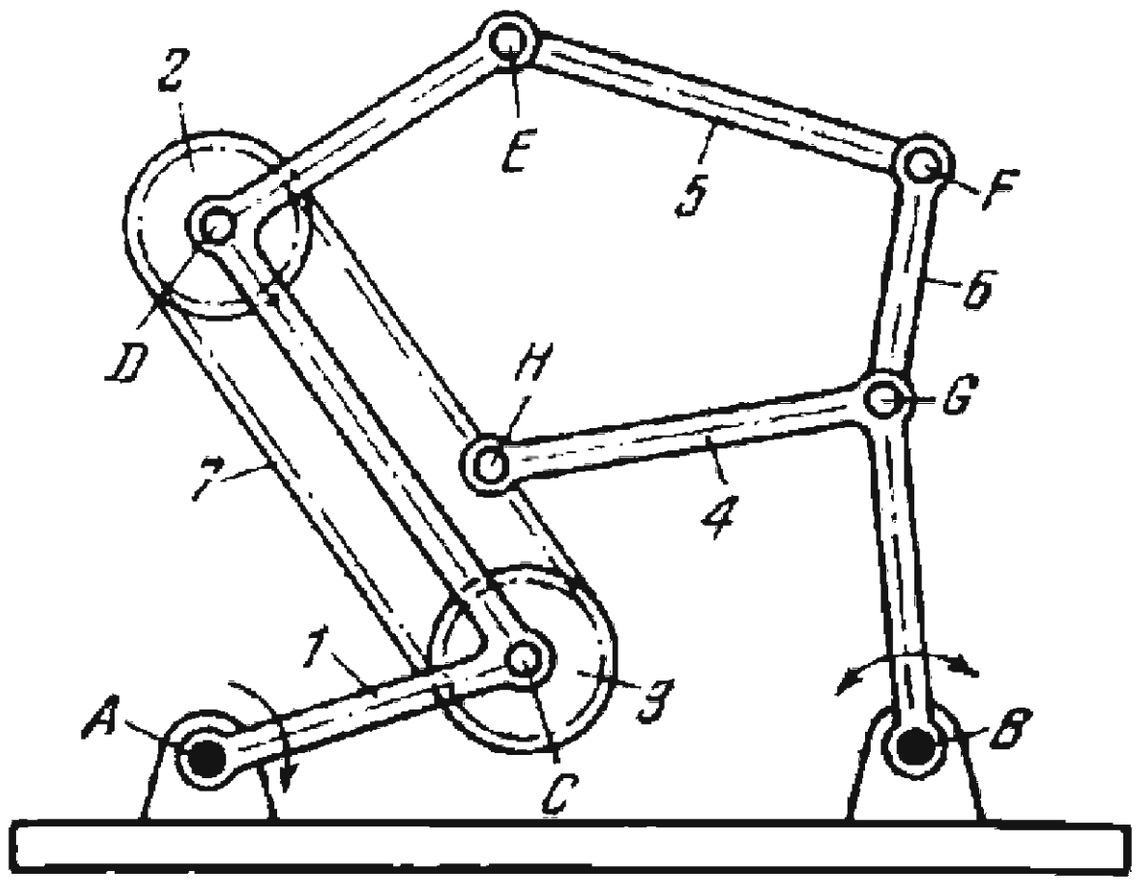
Link *3*, designed as a bent lever, is connected by turning pairs *H*, *E*, *F* and *G* to link *5*, to pulleys *2* and *6*, of equal diameter, and to link *4*. Flexible link *7* runs over the pulleys and is connected by turning pair *D* to link *1*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *C* to link *4*. Link *5* turns about fixed axis *B*. When link *1* turns about axis *A*, links *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2044	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



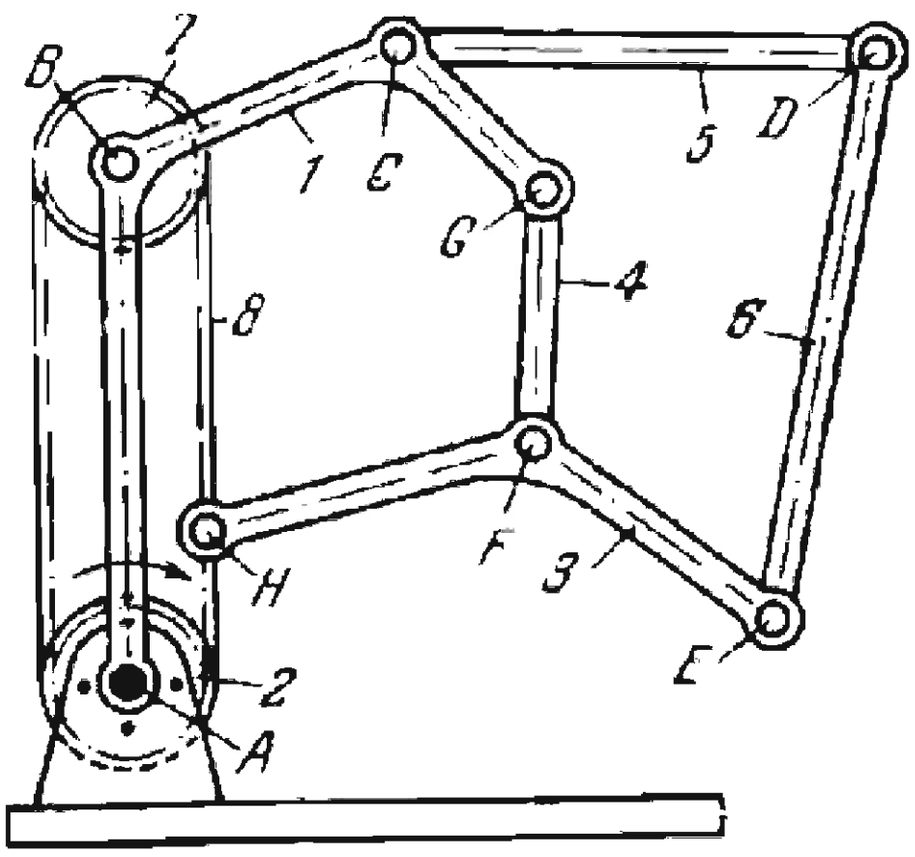
Link *3*, designed as a complex lever, turns about fixed axis *B* and is connected by turning pairs *C*, *D* and *F* to pulleys *2* and *5*, of equal diameter, and to link *4*. Flexible link *7* runs over the pulleys and is connected by turning pair *E* to link *6*. Link *6*, designed as a bent lever, is connected by turning pairs *G* and *H* to link *4* and to link *1* which turns about fixed axis *A*. When link *1* turns about axis *A*, links *4* and *6* have complex motions and link *3* oscillates about axis *B*.

2045	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



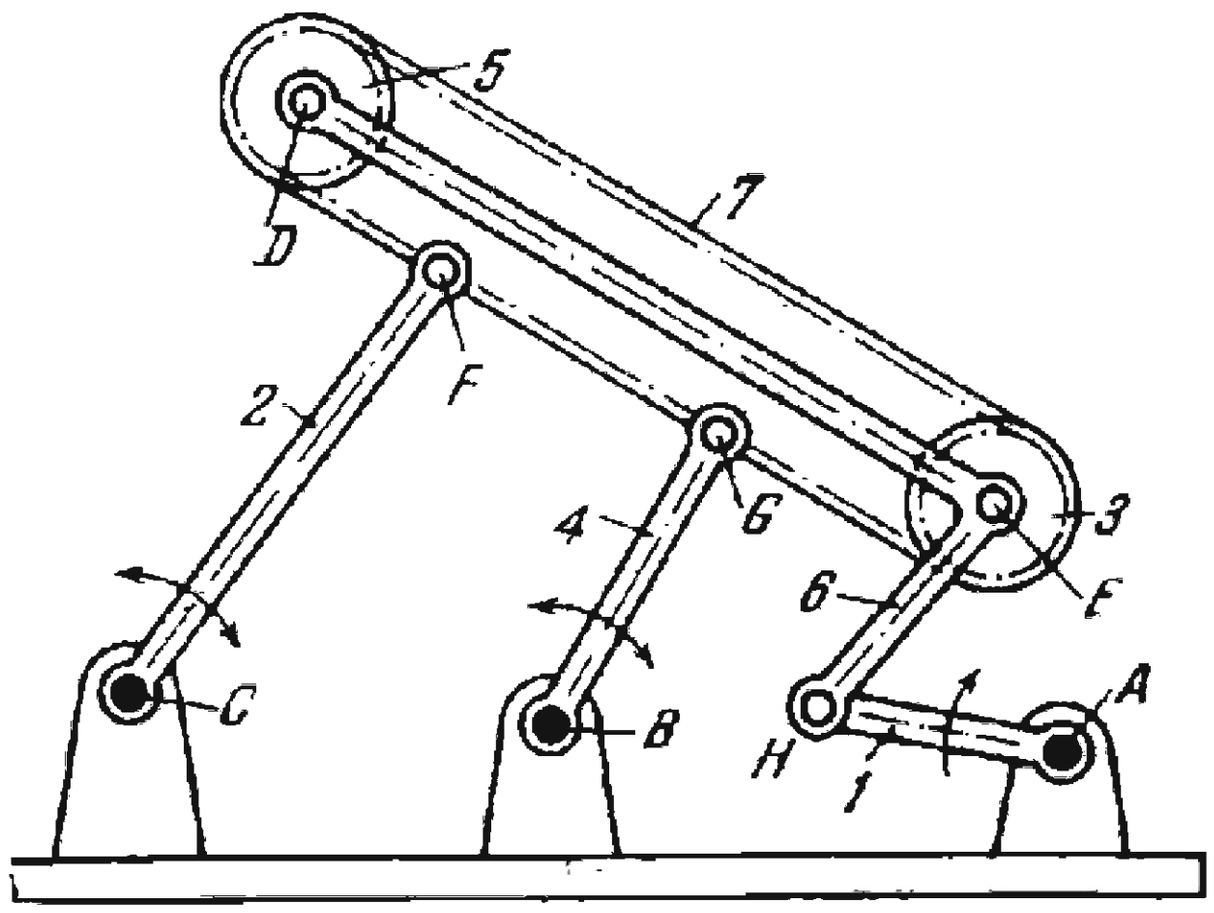
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *C*, *D* and *E* to pulleys *3* and *2*, of equal diameter, and to link *5*. Flexible link *7* runs over the pulleys and is connected by turning pair *H* to link *4*. Link *4*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pair *G* to link *6* which, in turn, is connected by turning pair *F* to link *5*. When link *1* turns about axis *A*, links *5* and *6* have complex motions and link *4* oscillates about axis *B*.

2046	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



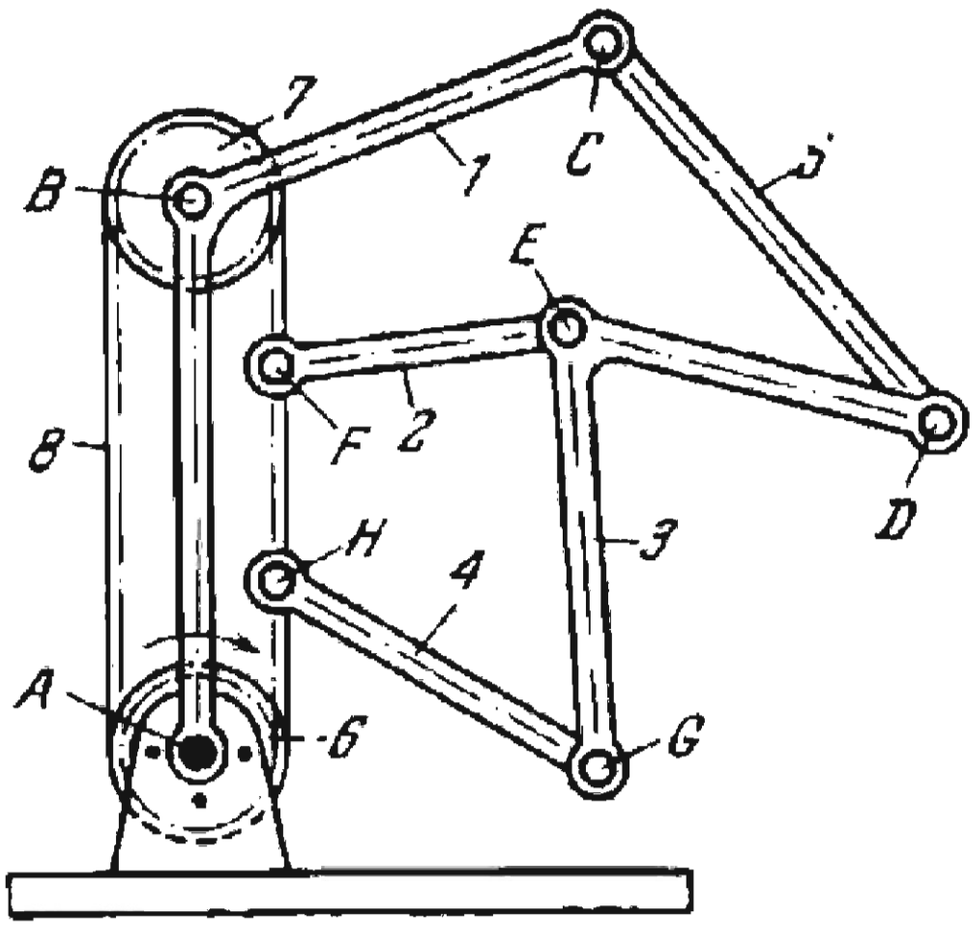
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *G* to pulley *7* and to links *5* and *4*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *H* to link *3*. Pulley *2* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *F* and *E* to links *4* and *6*. Links *5* and *6* are connected together by turning pair *D*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2047	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



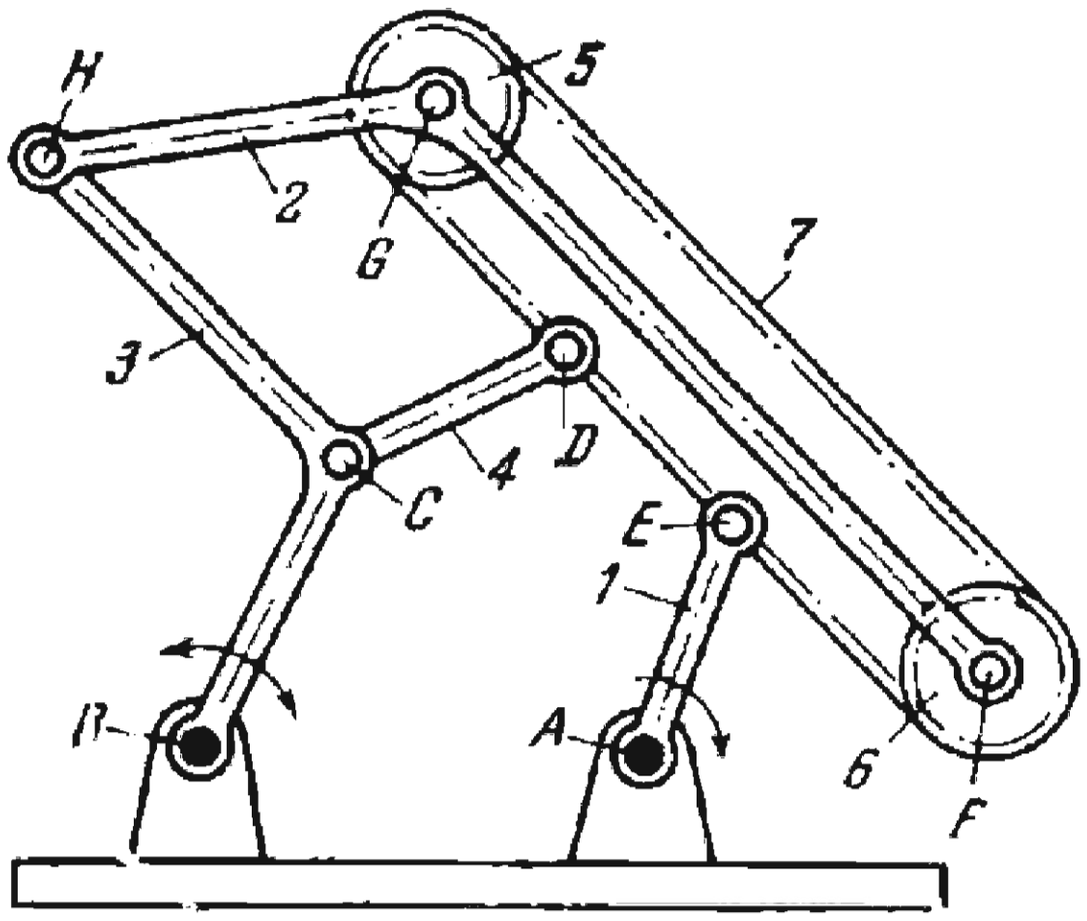
Link *6*, designed as a bent lever, is connected by turning pairs *H*, *E* and *D* to link *1* and to pulleys *3* and *5*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *F* and *G* to links *2* and *4*. Links *1*, *4* and *2* turn about fixed axes *A*, *B* and *C*. When link *1* turns about axis *A*, link *6* has a complex motion and links *4* and *2* oscillate about axes *B* and *C*.

2048	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



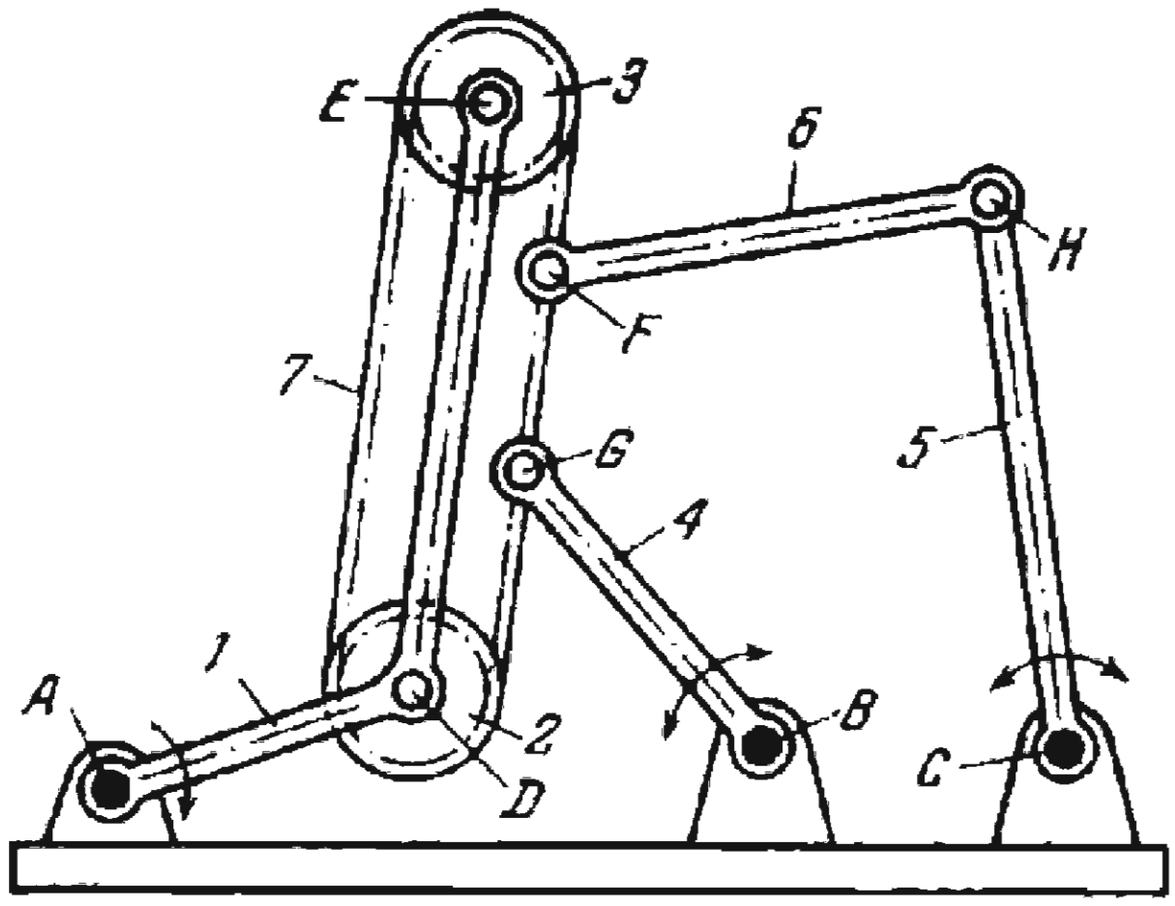
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to link *5*. Flexible link *8* runs over pulleys *6* and *7*, of equal diameter, and is connected by turning pairs *F* and *H* to links *2* and *4*. Pulley *6* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *D*, *E* and *G* to links *5*, *2* and *4*. When link *1* turns about axis *A*, links *2*, *3*, *4* and *5* have complex motions.

2049	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



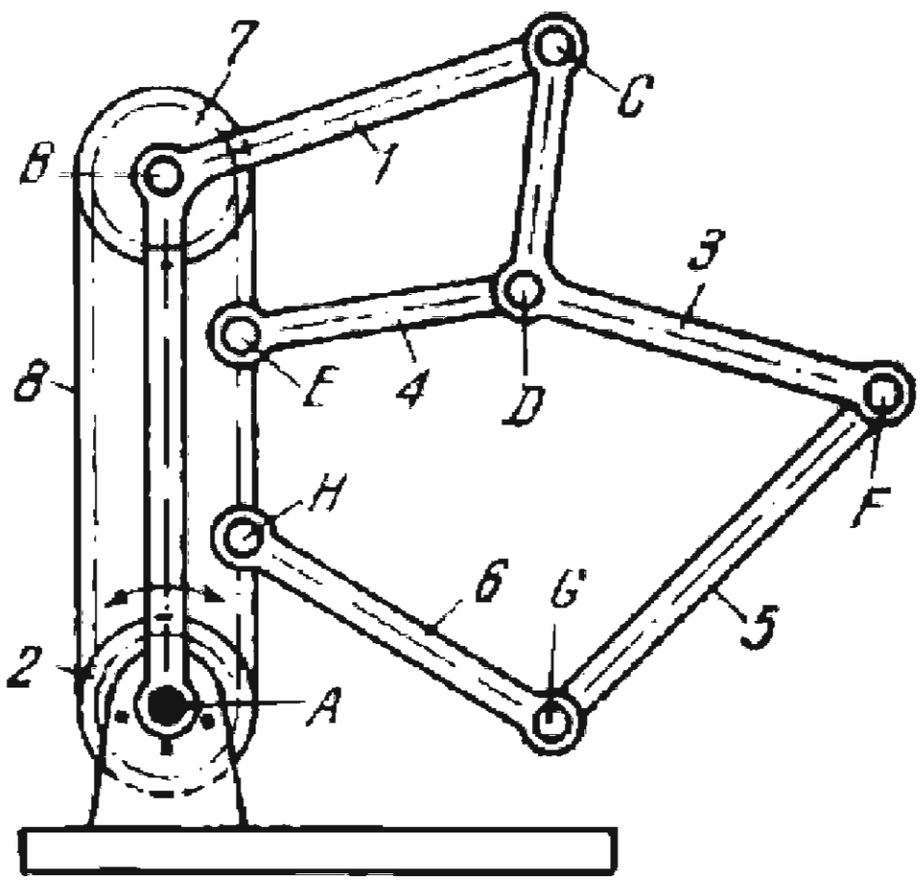
Link *2*, designed as a bent lever, is connected by turning pairs *F*, *G* and *H* to pulleys *6* and *5*, of equal diameter, and to link *3*. Flexible link *7* runs over the pulleys and is connected by turning pairs *D* and *E* to links *4* and *1*. Link *1* turns about fixed axis *A*. Link *3*, designed as a bent lever. turns about fixed axis *B* and is connected by turning pair *C* to link *4*. When link *1* turns about axis *A*, links *2* and *4* have complex motions and link *3* oscillates about axis *B*.

2050	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



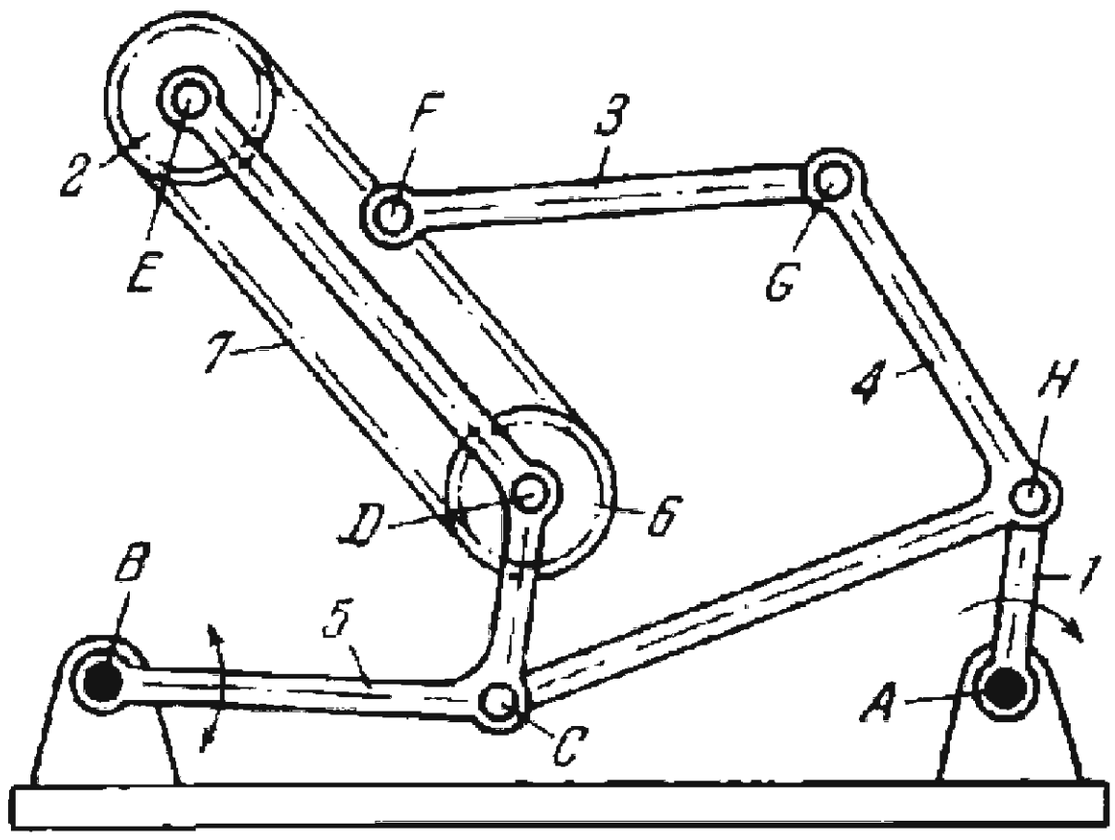
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *D* and *E* to pulleys *2* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *F* and *G* to links *6* and *4*. Link *4* turns about fixed axis *B*. Link *5* turns about fixed axis *C* and is connected by turning pair *H* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion and links *4* and *5* oscillate about axes *B* and *C*.

2051	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



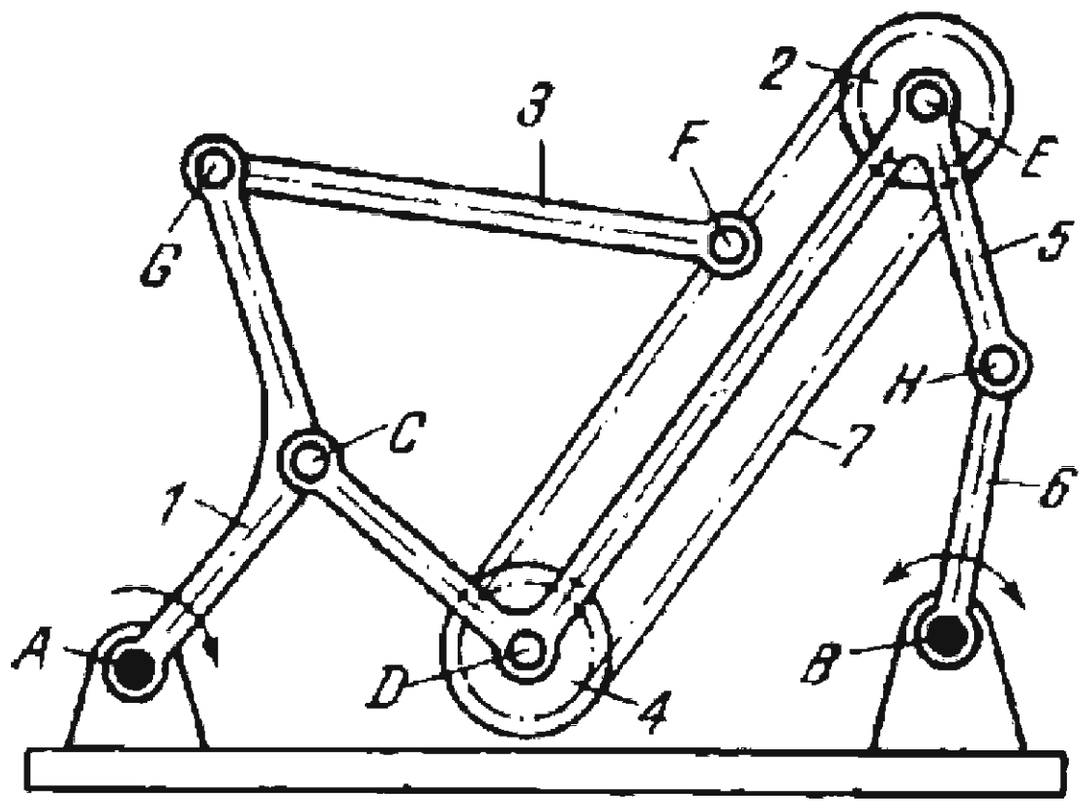
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and link *3*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pairs *E* and *H* to links *4* and *6*. Pulley *2* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *D* and *F* to links *4* and *5*. Links *5* and *6* are connected together by turning pair *G*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2052	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



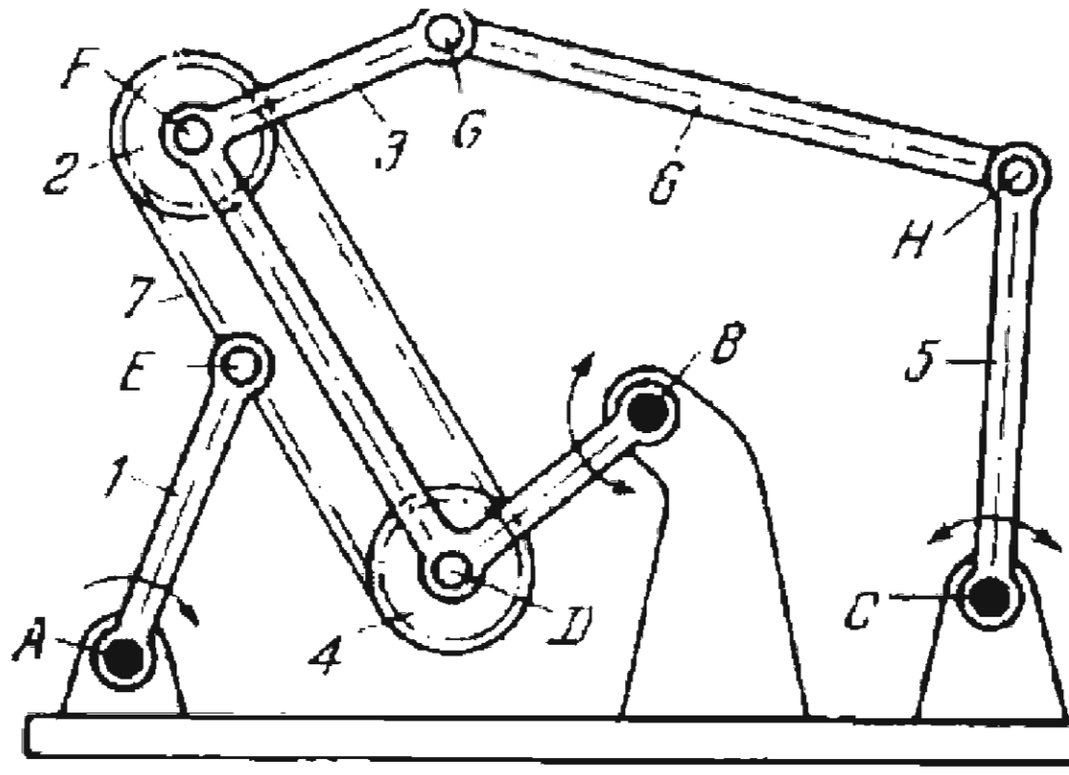
Link *5*, designed as a complex lever, turns about fixed axis *B* and is connected by turning pairs *C*, *D* and *E* to link *4* and to pulleys *6* and *2*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *F* to link *3*. Link *4*, designed as a bent lever, is connected by turning pairs *G* and *H* to link *3* and link *1* which turns about fixed axis *A*. When link *1* turns about axis *A*, links *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2053	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



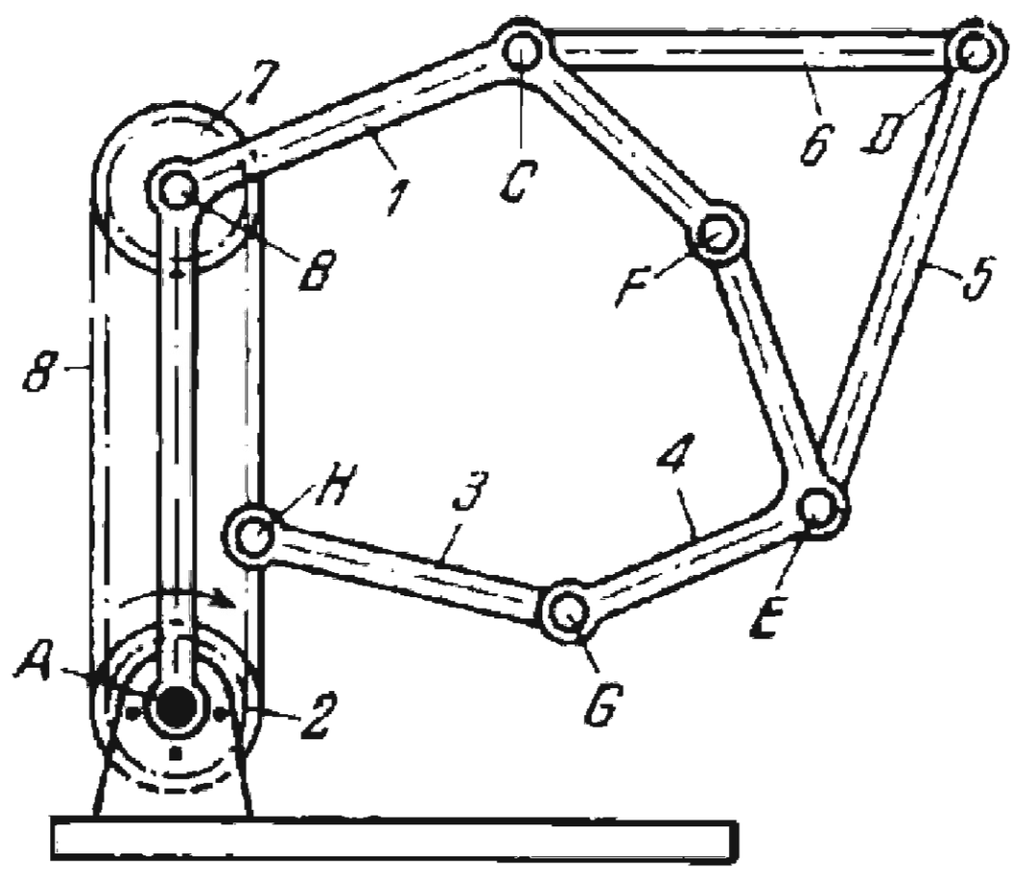
Link *5*, designed as a complex lever, is connected by turning pairs *C*, *D*, *E* and *H* to link *1*, to pulleys *4* and *2*, of equal diameter, and to link *6*. Flexible link *7* runs over the pulleys and is connected by turning pair *F* to link *3*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *G* to link *3*. Link *6* turns about fixed axis *B*. When link *1* turns about axis *A*, links *3* and *5* have complex motions and link *6* oscillates about axis *B*.

2054	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



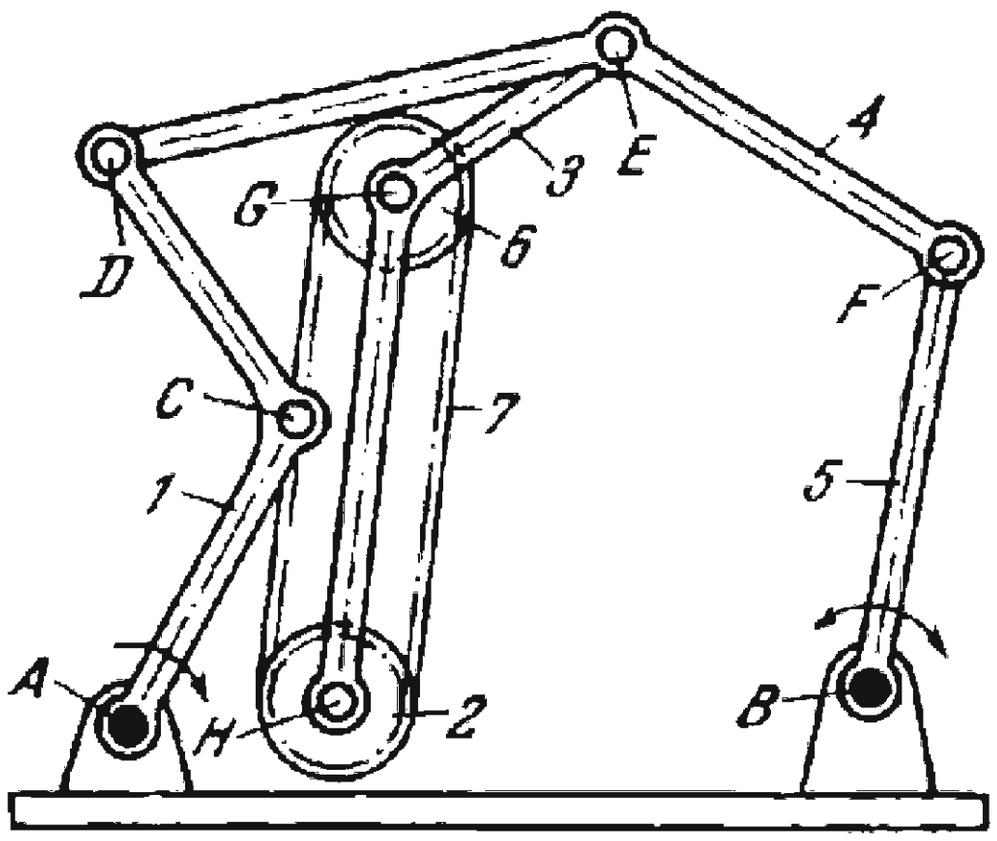
Link *3*, designed as a complex lever, turns about fixed axis *B* and is connected by turning pairs *D*, *F* and *G* to pulleys *4* and *2*, of equal diameter, and to link *6*. Flexible link *7* runs over the pulleys and is connected by turning pair *E* to link *1* which turns about fixed axis *A*. Link *5* turns about fixed axis *C* and is connected by turning pair *H* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion and links *3* and *5* oscillate about axes *B* and *C*.

2055	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



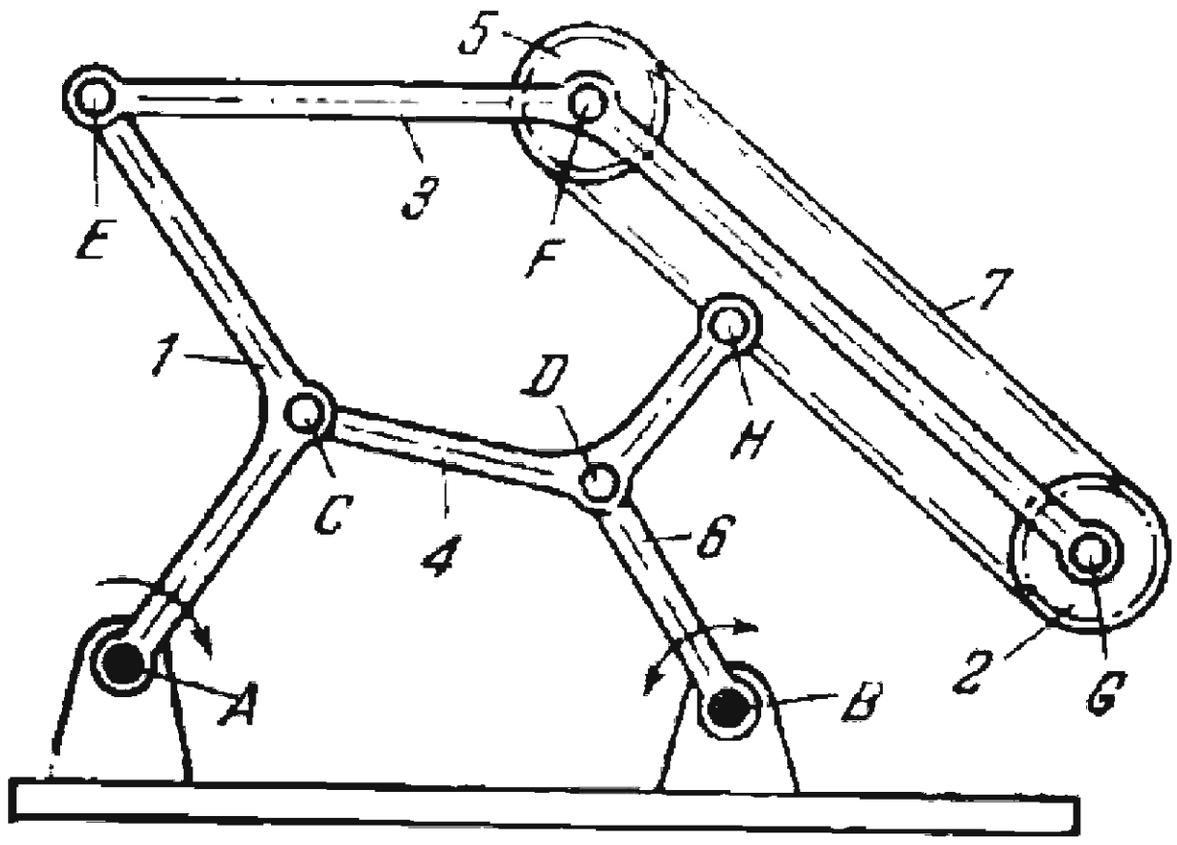
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *F* to pulley *7* and to links *6* and *4*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *H* to link *3*. Pulley *2* is rigidly attached to the base. Link *4*, designed as a bent lever, is connected by turning pairs *E* and *G* to links *5* and *3*. Links *5* and *6* are connected together by turning pair *D*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2056	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



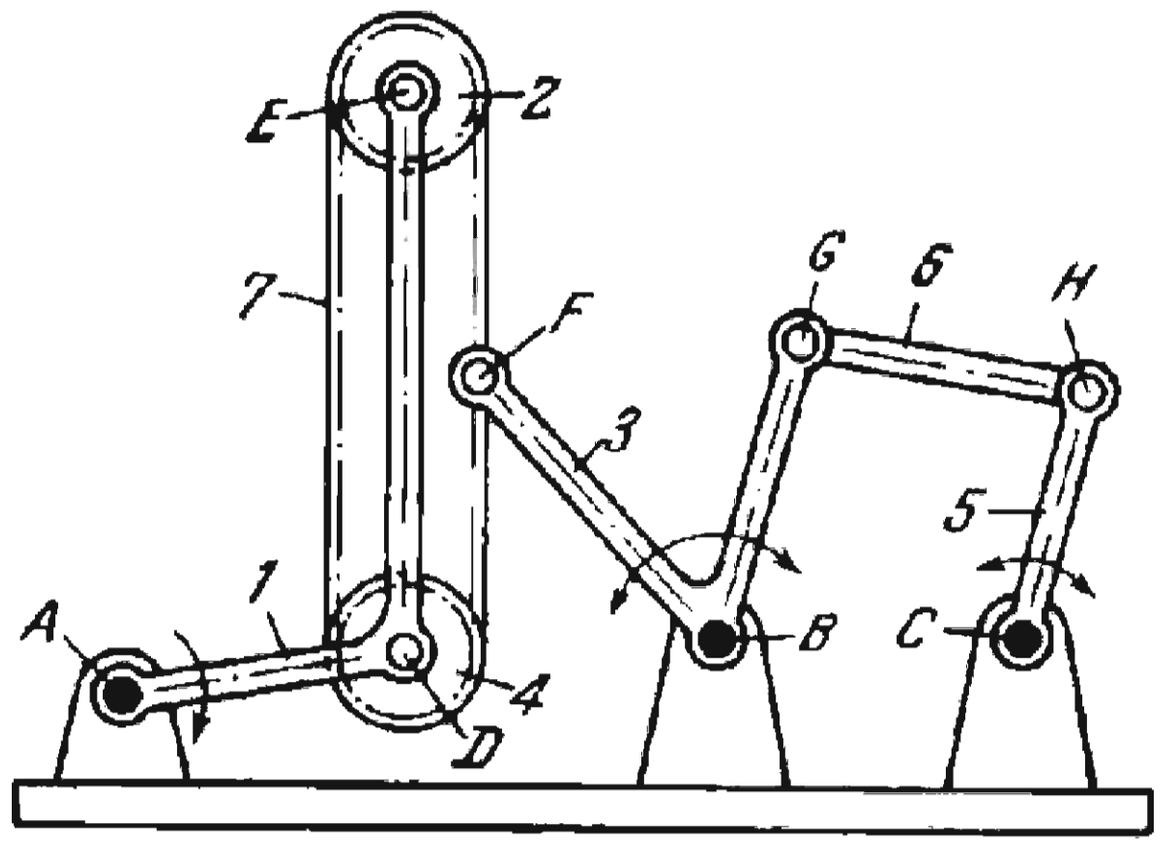
Link *3*, designed as a bent lever, is connected by turning pairs *H*, *G* and *E* to pulleys *2* and *6*, of equal diameter, and to link *4*. Flexible link *7* runs over the pulleys and is connected by turning pair *C* to link *1*. Link 1, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *D* to link *4*. Link *5* turns about fixed axis *B* and is connected by turning pair *F* to link *4*. When link *1* turns about axis *A*, links *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2057	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



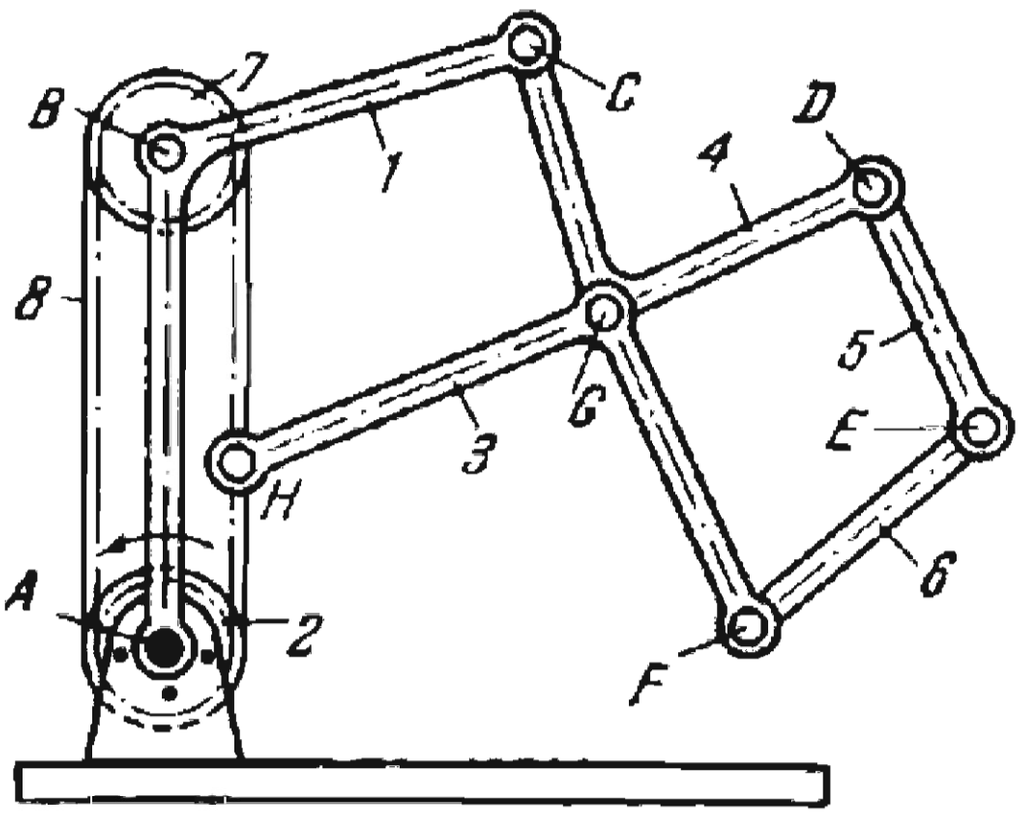
Link *3*, designed as a bent lever, is connected by turning pairs *E*, *F* and *G* to link *1* and to pulleys *5* and *2*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *H* to link *4*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *C* to link *4*, also designed as a bent lever. Link *6* turns about fixed axis *B* and is connected by turning pair *D* to link *4*. When link *1* turns about axis *A*, links *3* and *4* have complex motions and link *6* oscillates about axis *B*.

2058	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



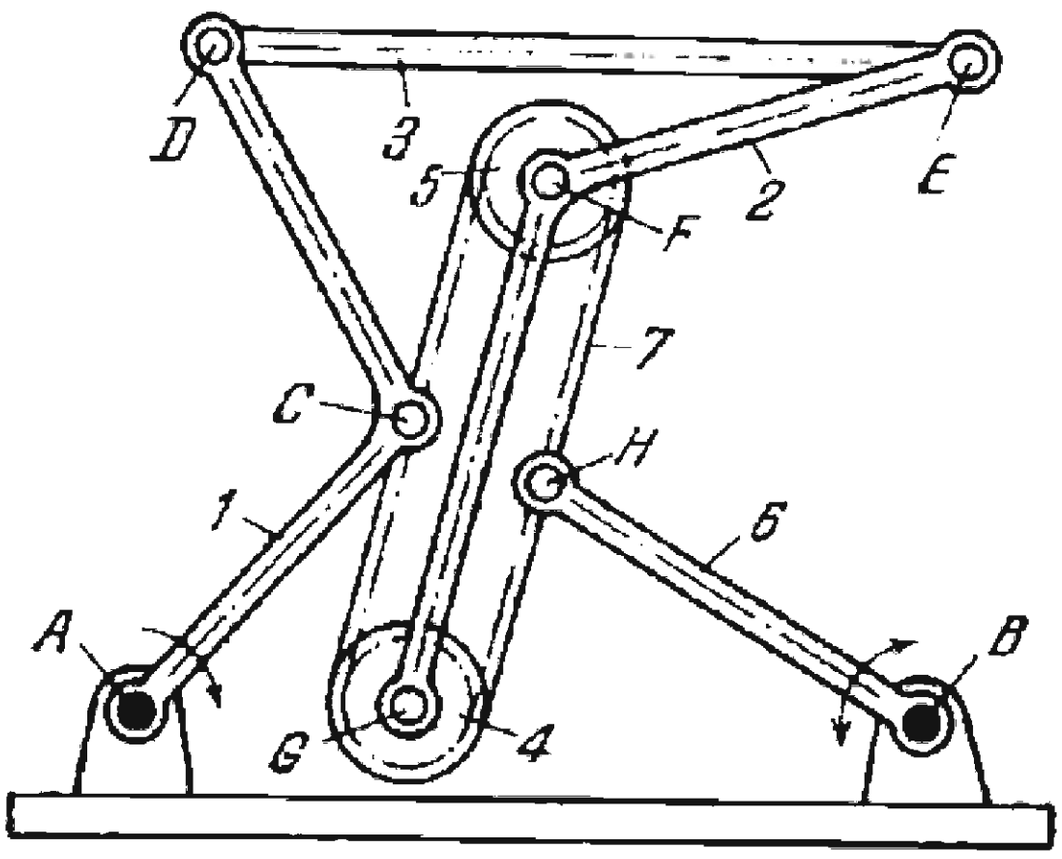
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *D* and *E* to pulleys *4* and *2*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *F* to link *3*. Link *3*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pair *G* to link *6*. Link *5* turns about fixed axis *C* and is connected by turning pair *H* to link *6*. When link *1* turns about axis *A*, lever *6* has a complex motion and links *3* and *5* oscillate about axes *B* and *C*.

2059	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



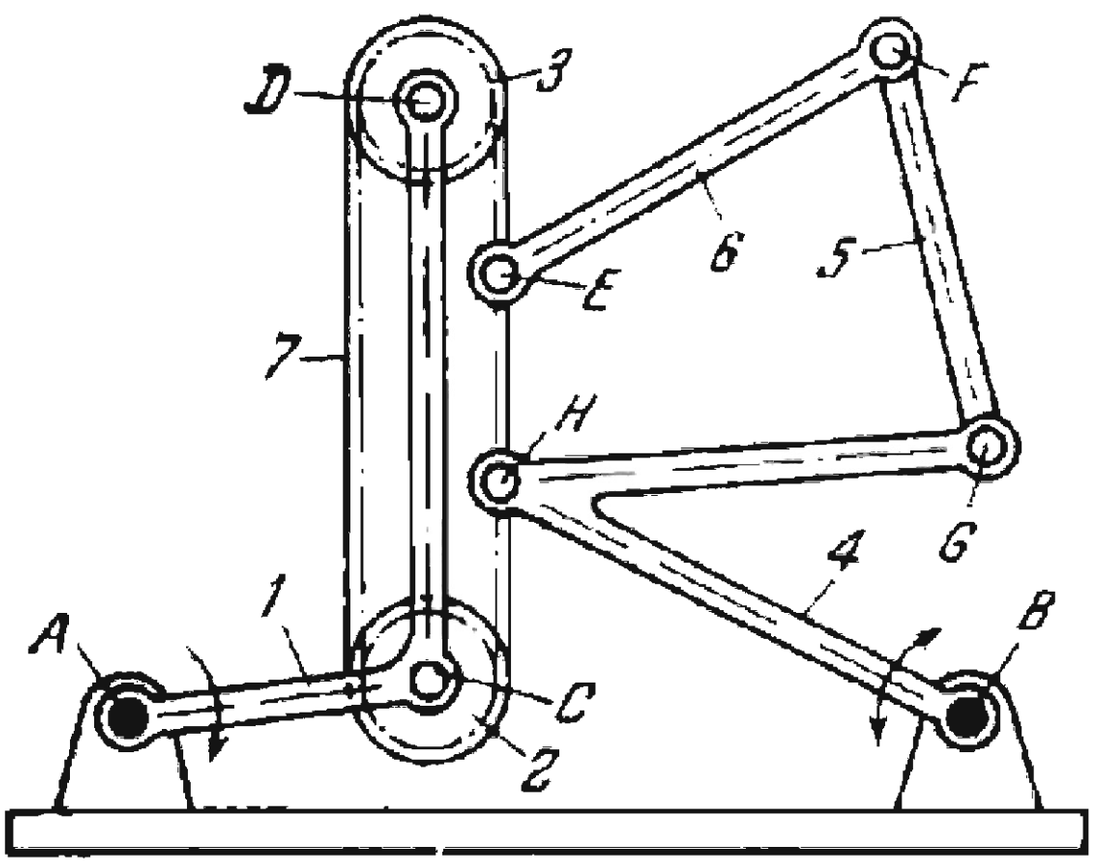
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to link *4*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *H* to link *3*. Pulley *2* is rigidly attached to the base. Links *4* and *3*, designed as bent levers, are connected together by turning pair *G* and to links *5* and *6* by turning pairs *D* and *F*. Links *5* and *6* are connected together by turning pair *E*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2060	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



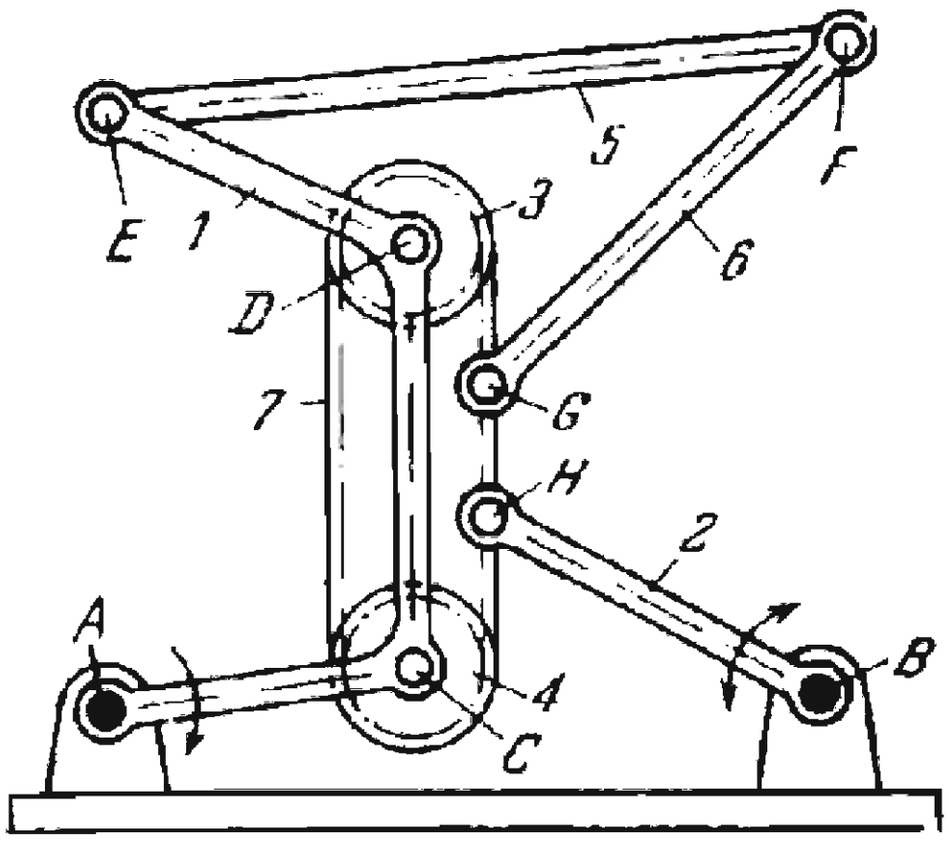
Link *2*, designed as a bent lever, is connected by turning pairs *G*, *F* and *E* to pulleys *4* and *5*, of equal diameter, and to link *3*. Flexible link *7* runs over the pulleys and is connected by turning pairs *C* and *H* to links *1* and *6*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *D* to link *3*. Link *6* turns about fixed axis *B*. When link *1* turns about axis *A*, links *2* and *3* have complex motions and link *6* oscillates about axis *B*.

2061	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



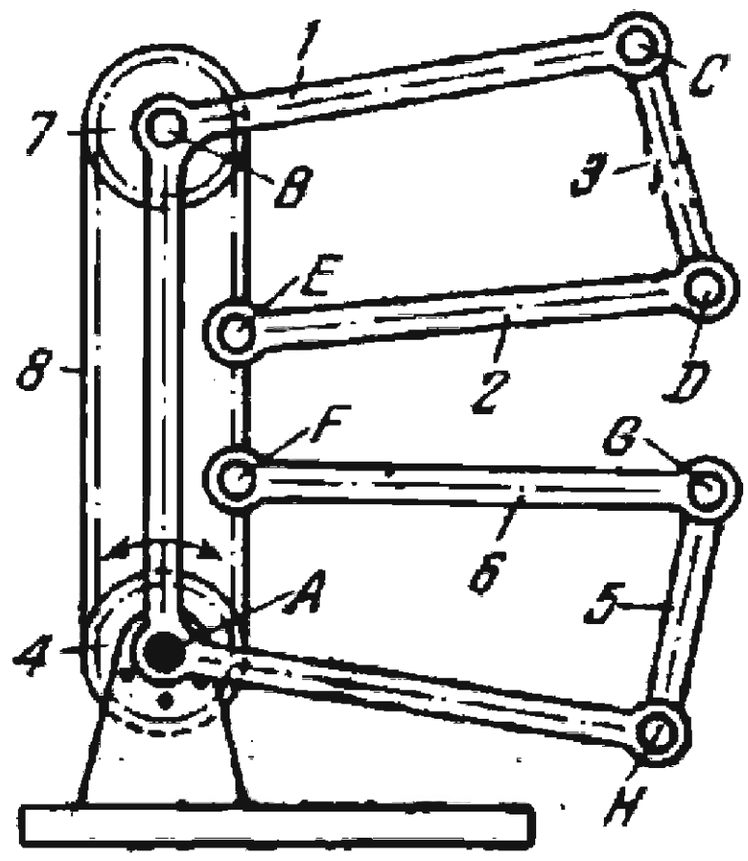
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *C* and *D* to pulleys *2* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *E* and *H* to links *6* and *4*. Link *4*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pair *G* to link *5* which, in turn, is connected by turning pair *F* to link *6*. When link *1* turns about axis *A*, links *5* and *6* have complex motions, and link *4* oscillates about axis *B*.

2062	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



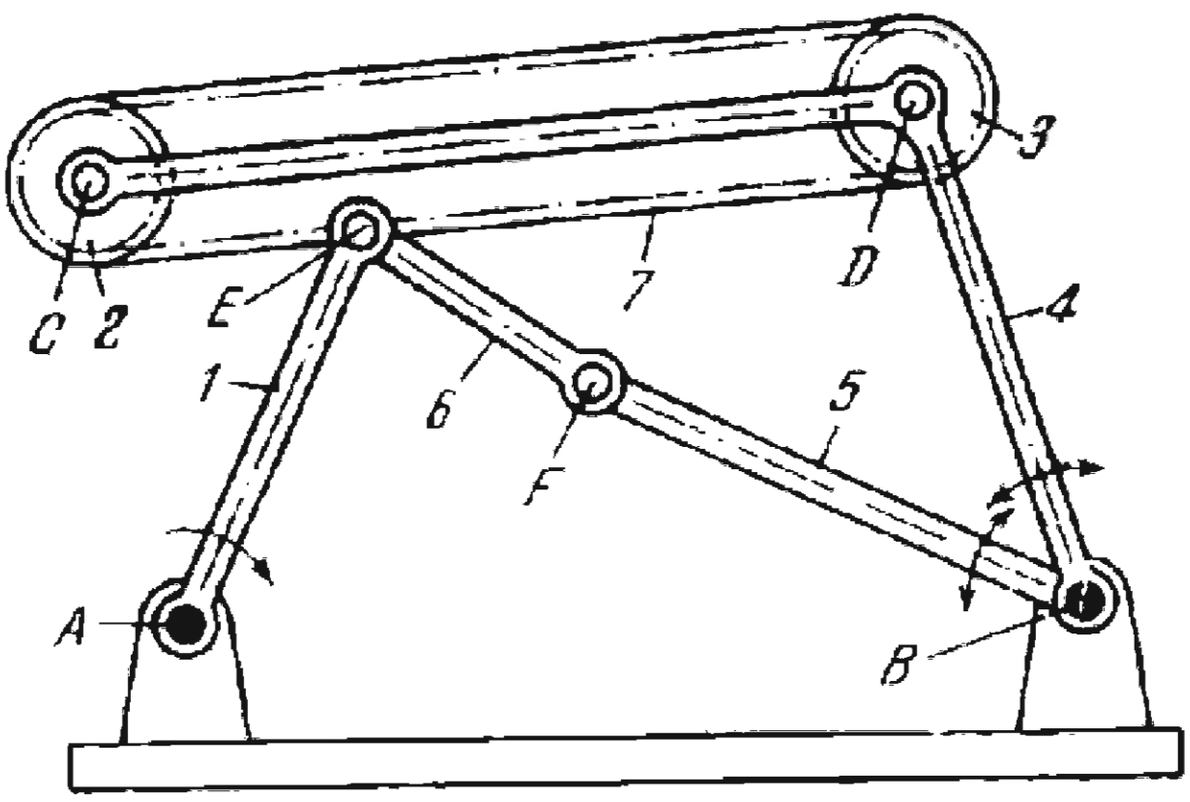
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *C*, *D* and *E* to pulleys *4* and *3*, of equal diameter, and to link *5*. Flexible link *7* runs over the pulleys and is connected by turning pairs *G* and *H* to links *6* and *2*. Link *2* turns about fixed axis *B*. Links *6* and *5* are connected together by turning pair *F*. When link *1* turns about axis *A*, links *5* and *6* have complex motions and link *2* oscillates about axis *B*.

2063	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



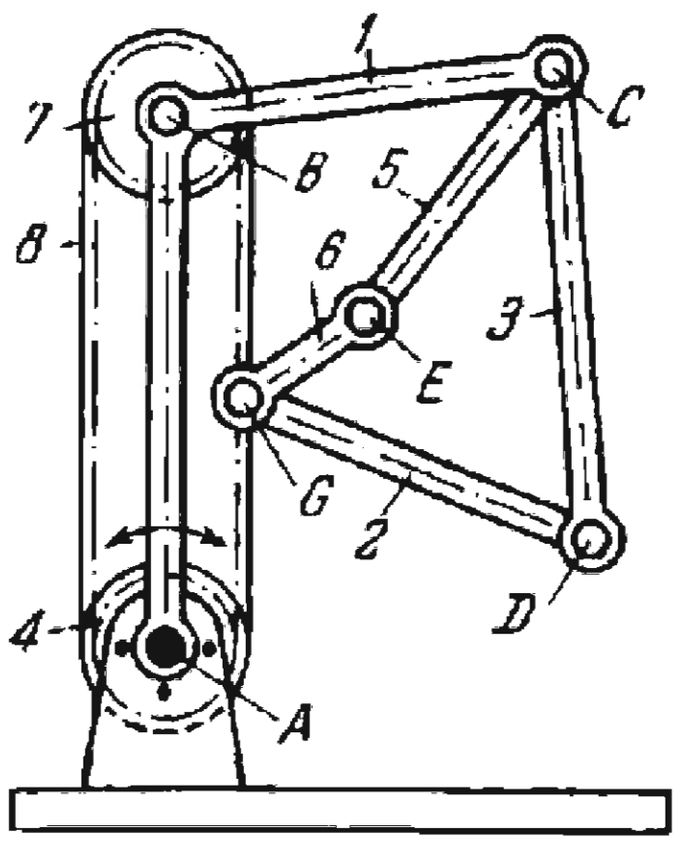
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *H* to pulley *7* and to links *3* and *5*. Flexible link *8* runs over pulleys *4* and *7*, of equal diameter, and is connected by turning pairs *E* and *F* to links *2* and *6*. Pulley *4* is rigidly attached to the base. Links *3* and *5* are connected by turning pairs *D* and *G* to links *2* and *6*. When link *1* turns about axis *A*, links *2*, *3*, *5* and *6* have complex motions.

2064	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



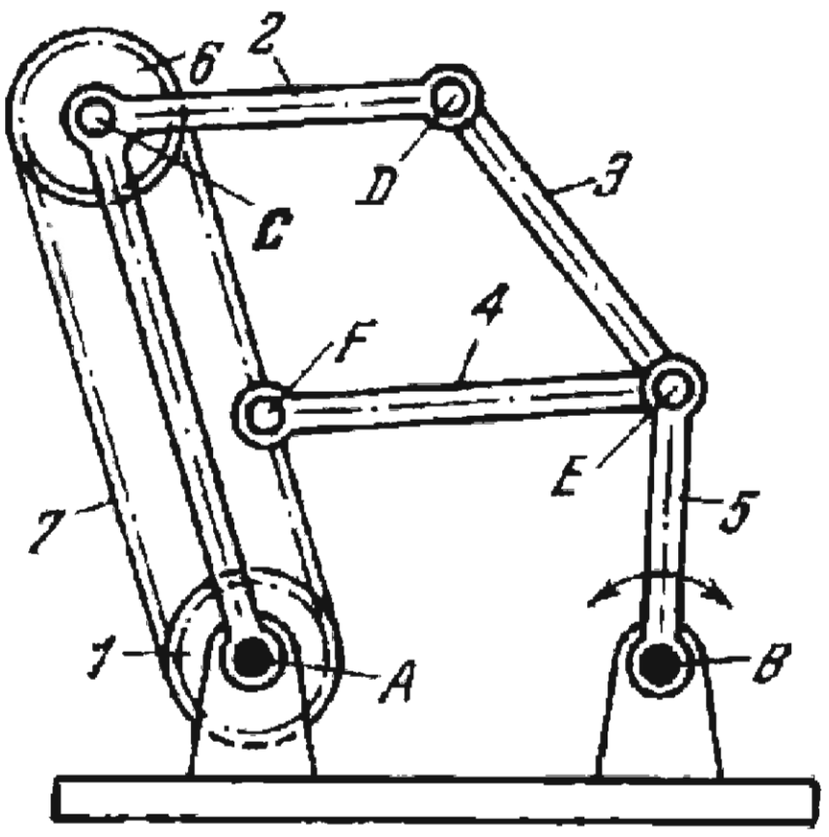
Link *4*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *C* and *D* to pulleys *2* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *E* to links *1* and *6*. Link *1* turns about fixed axis *A*. Link *5* turns about axis *B* and is connected by turning pair *F* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion and links *4* and *5* oscillate about axis *B*.

2065	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



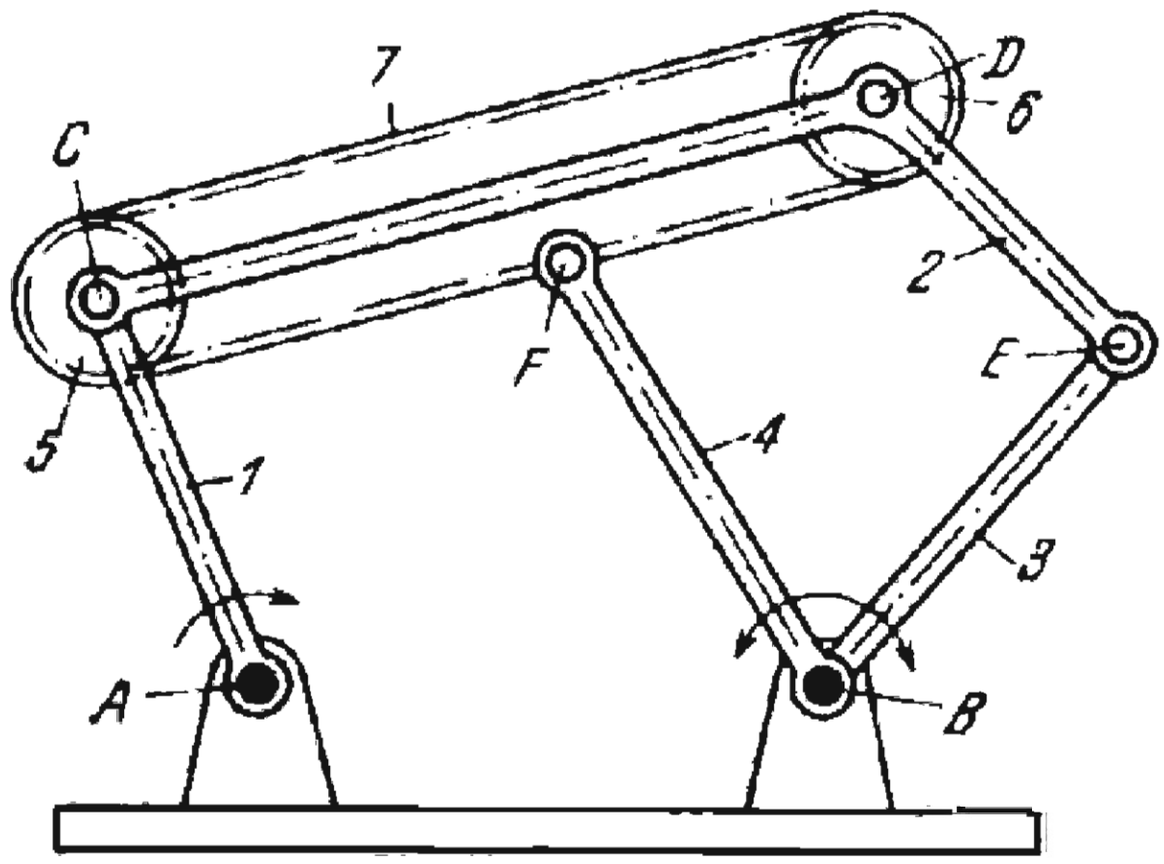
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to links *5* and *3*. Flexible link *8* runs over pulleys *4* and *7*, of equal diameter, and is connected by turning pairs *G* to links *6* and *2*. Pulley *4* is rigidly attached to the base. Links *3* and *5* are connected by turning pairs *D* and *E* to links *2* and *6*. When link *1* turns about axis *A*, links *2*, *3*, *5* and *6* have complex motions.

2066	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



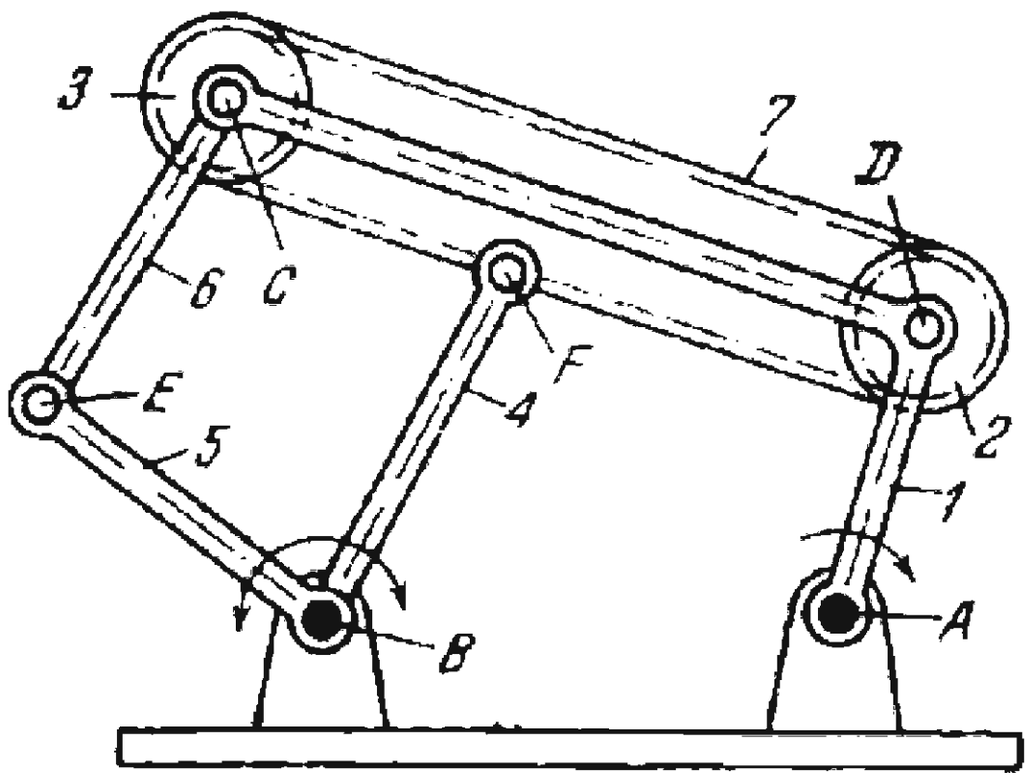
Pulley *1* rotates about fixed axis *A*. Link *2*, designed as a bent lever, turns about axis *A* and is connected by turning pairs *C* and *D* to pulley *6* and to link *3*. Flexible link *7* runs over pulleys *1* and *6*, of equal diameter, and is connected by turning pair *F* to link *4*. Link *5* turns about fixed axis *B* and is connected by turning pairs *E* to links *3* and *4*. When pulley *1* rotates about axis *A*, links *3* and *4* have complex motions and links *2* and *5* oscillate about axes *A* and *B*.

2067	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



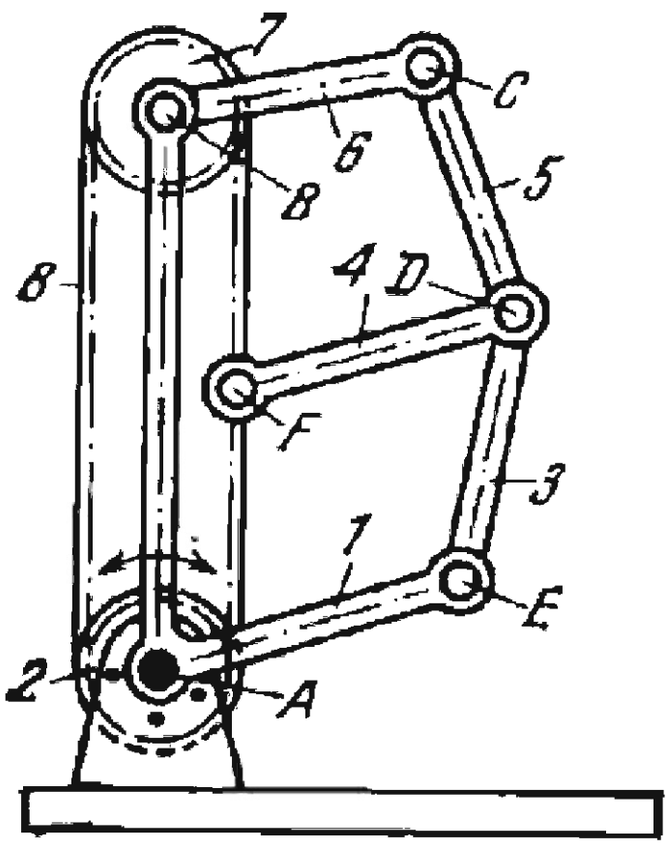
Link *2*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to pulleys *5* and *6*, of equal diameter, and to link *3* which turns about fixed axis *B*. Flexible link *7* runs over the pulleys and is connected by turning pair *F* to link *4* which turns about axis *B*. Link *1* turns about fixed axis *A* and is connected by turning pair *C* to link *2*. When link *1* turns about axis *A*, link *2* has a complex motion and links *3* and *4* oscillate about axis *B*.

2068	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



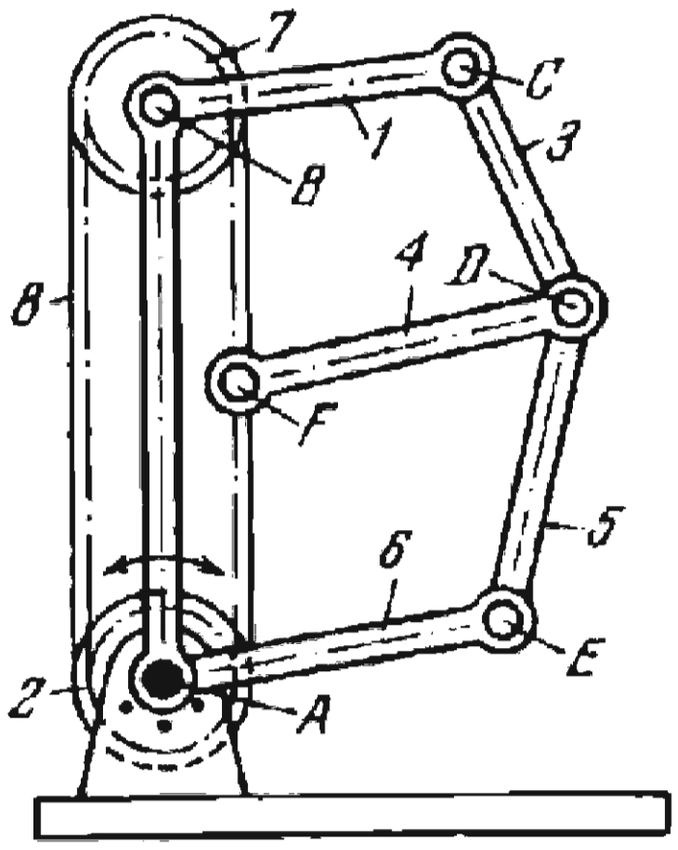
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *D* and *C* to pulleys *2* and *3*, of equal diameter, and to link *6*. Flexible link *7* runs over the pulleys and is connected by turning pair *F* to link *4* which turns about fixed axis *B*. Link *5* turns about axis *B* and is connected by turning pair *E* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion and links *4* and *5* oscillate about axis *B*.

2069	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



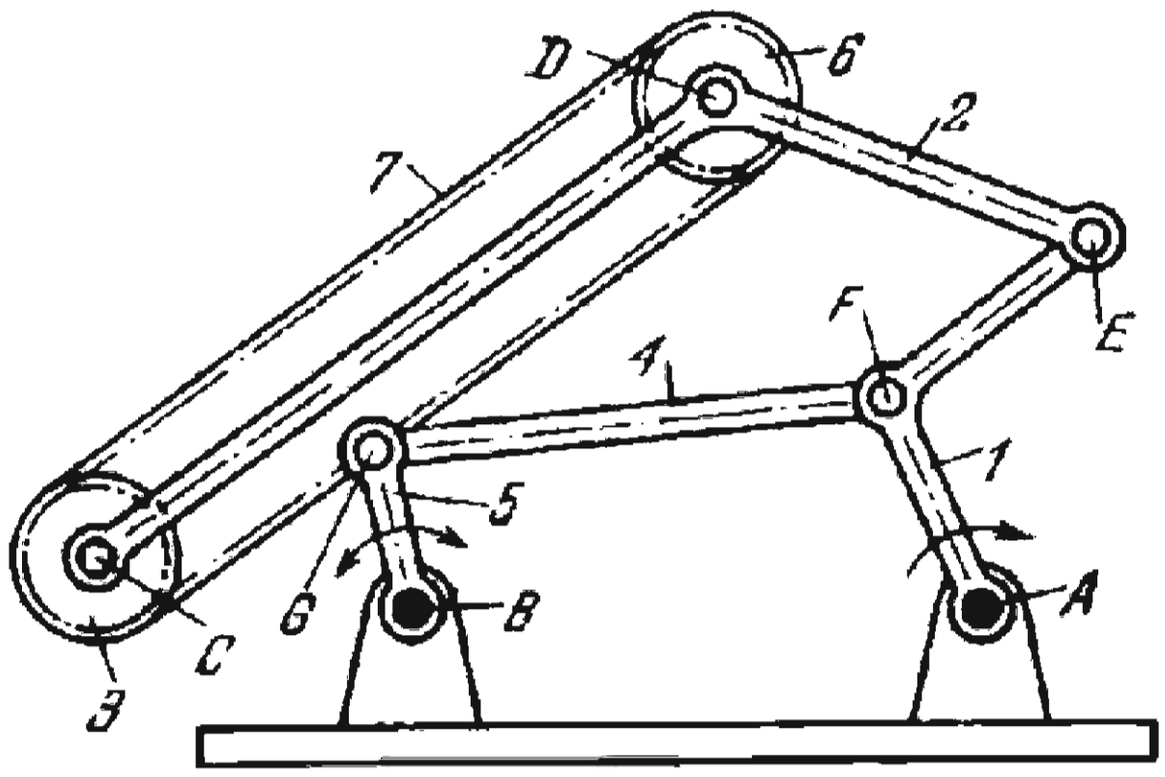
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *E* to pulley *7* and to link *3*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *F* to link *4*. Pulley *2* is rigidly attached to the base. Link *6* is connected by turning pairs *B* and *C* to pulley *7* and to link *5*. Link *5* is connected by turning pairs *D* to links *3* and *4*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2070	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



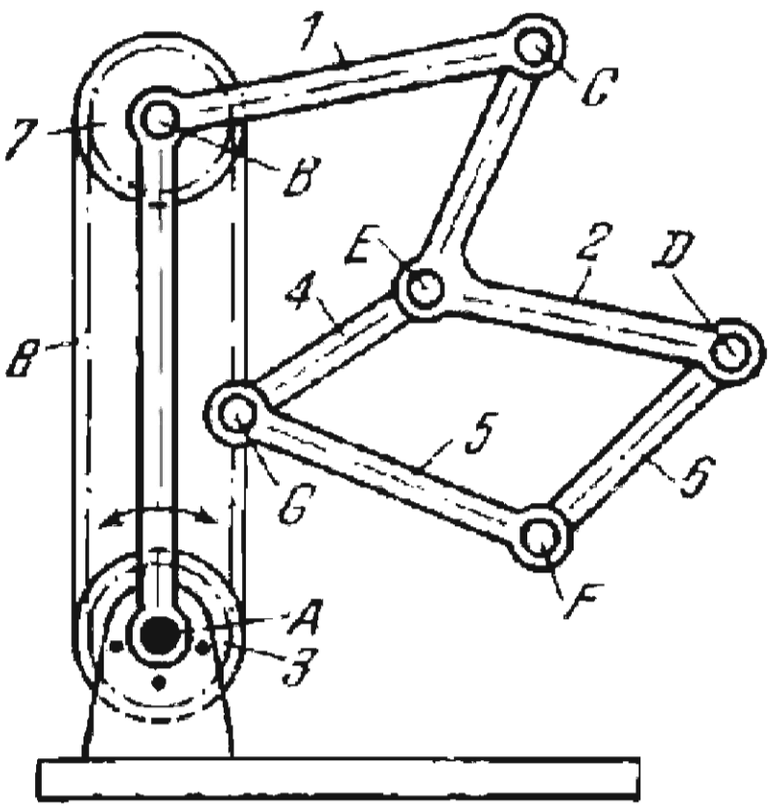
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to link *3*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *F* to link *4*. Pulley *2* is rigidly attached to the base. Link *5* is connected by turning pairs *D* and *E* to links *3*, *4* and *6*. Link *6* turns about axis *A*. When link *1* turns about axis *A*, links *3*, *4* and *5* have complex motions and link *6* oscillates about axis *A*.

2071	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



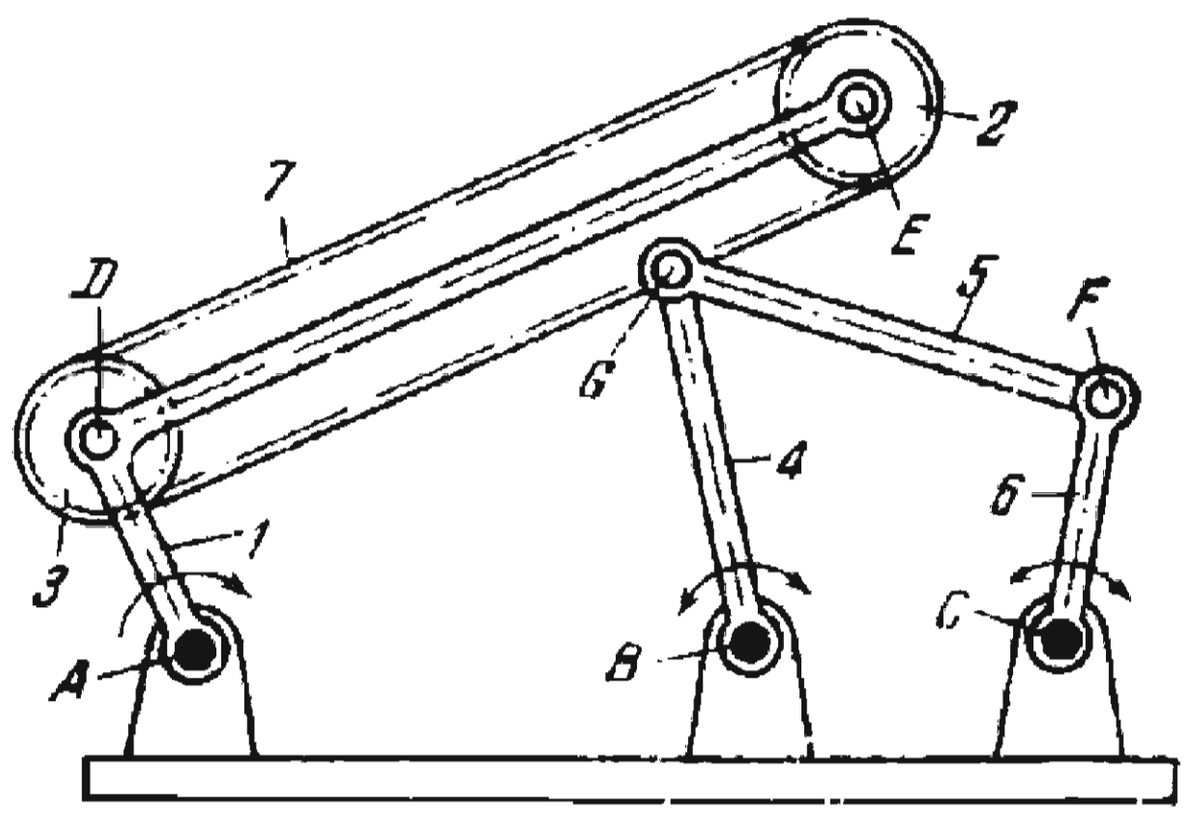
Link *2*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to pulleys *3* and *6*, of equal diameter, and to link *1*. Flexible link *7* runs over the pulleys and is connected by turning pairs *G* to links *4* and *5*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *F* to link *4*. Link *5* turns about fixed axis *B*. When link *1* turns about axis *A*, links *2* and *4* have complex motions and link *5* oscillates about axis *B*.

2072	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



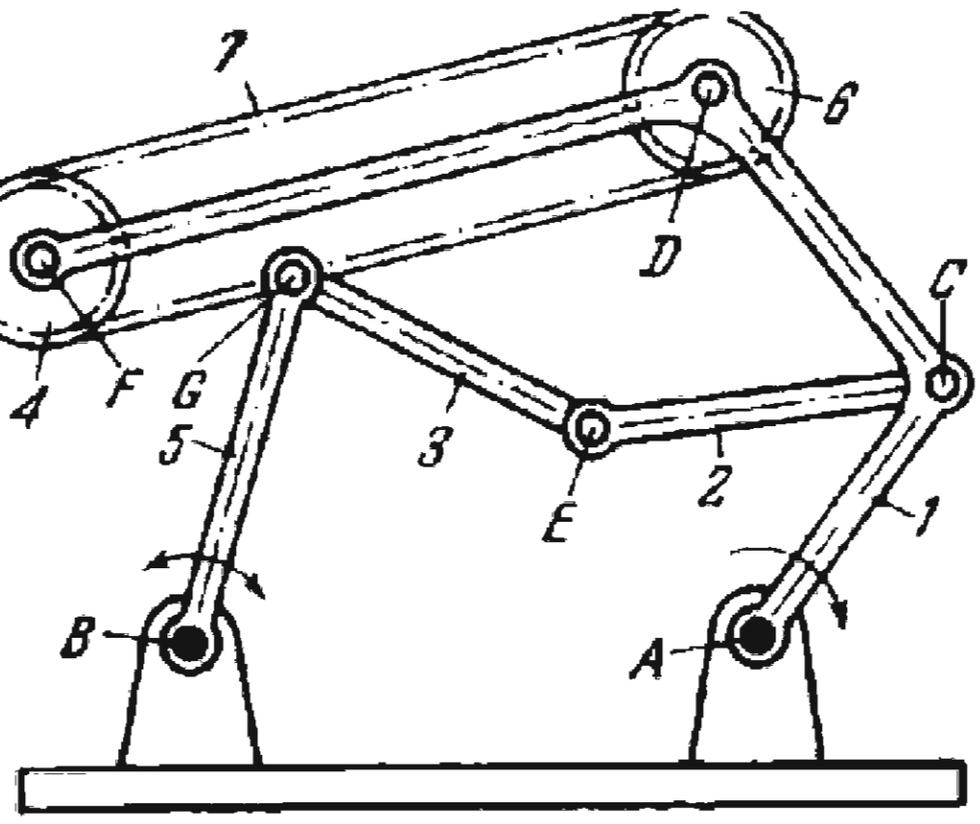
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to link *2*. Flexible link *8* runs over pulleys *3* and *7*, of equal diameter, and is connected by turning pairs *G* to links *4* and *5*. Pulley *3* is rigidly secured to the base. Link *2*, designed as a bent lever, is connected by turning pairs *E* and *D* to links *4* and *6*. Links *5* and *6* are connected together by turning pair *F*. When link *1* turns about axis *A*, links *2*, *4*, *5* and *6* have complex motions.

2073	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



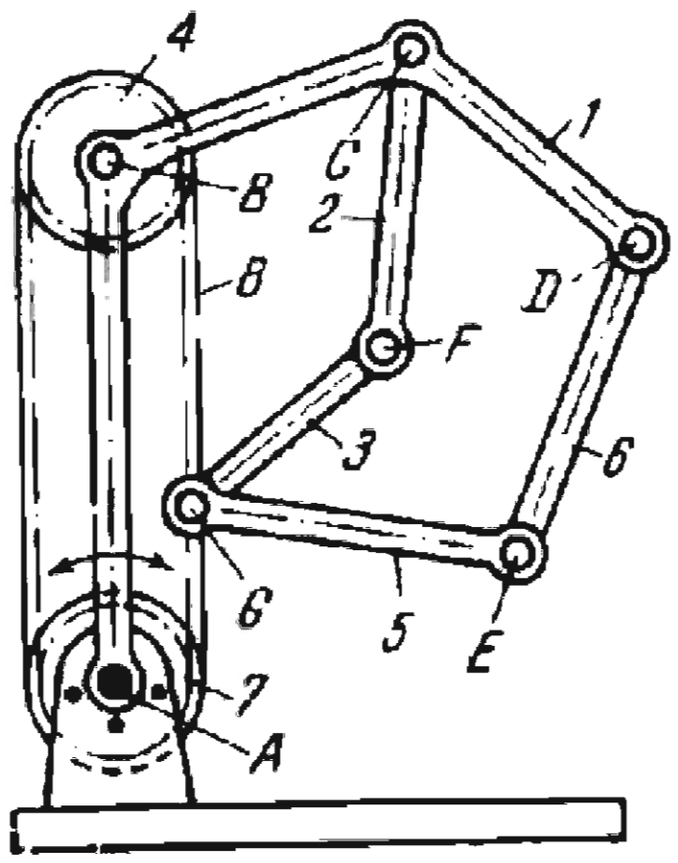
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *D* and *E* to pulleys *2* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *G* to links *4* and *5*. Link *4* turns about fixed axis *B*. Link *6* turns about fixed axis *C* and is connected by turning pair *F* to link *5*. When link *1* turns about axis *A*, link *5* has a complex motion and links *4* and *6* oscillate about axes *B* and *C*.

2074	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



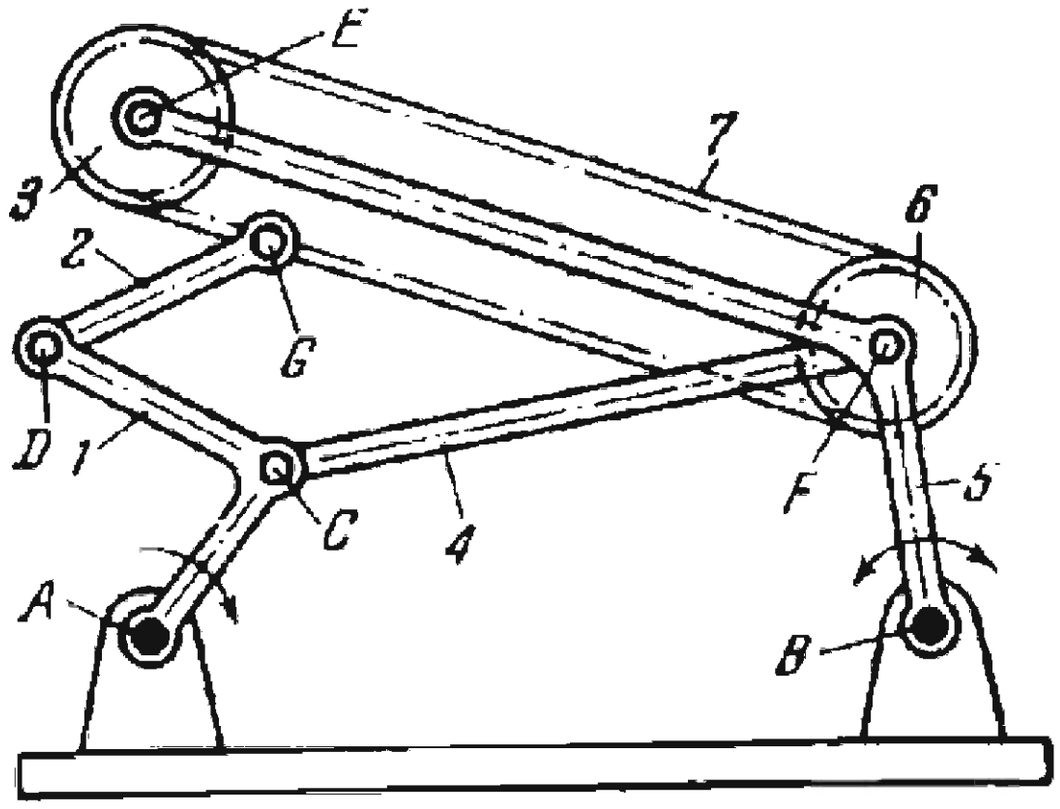
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *C*, *D* and *F* to link *2* and to pulleys *6* and *4*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pairs *G* to links *3* and *5*. Link *5* turns about fixed axis *B*. Links *2* and *3* are connected together by turning pair *E*. When link *1* turns about axis *A*, links *2* and *3* have complex motions and link *5* oscillates about axis *B*.

2075	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



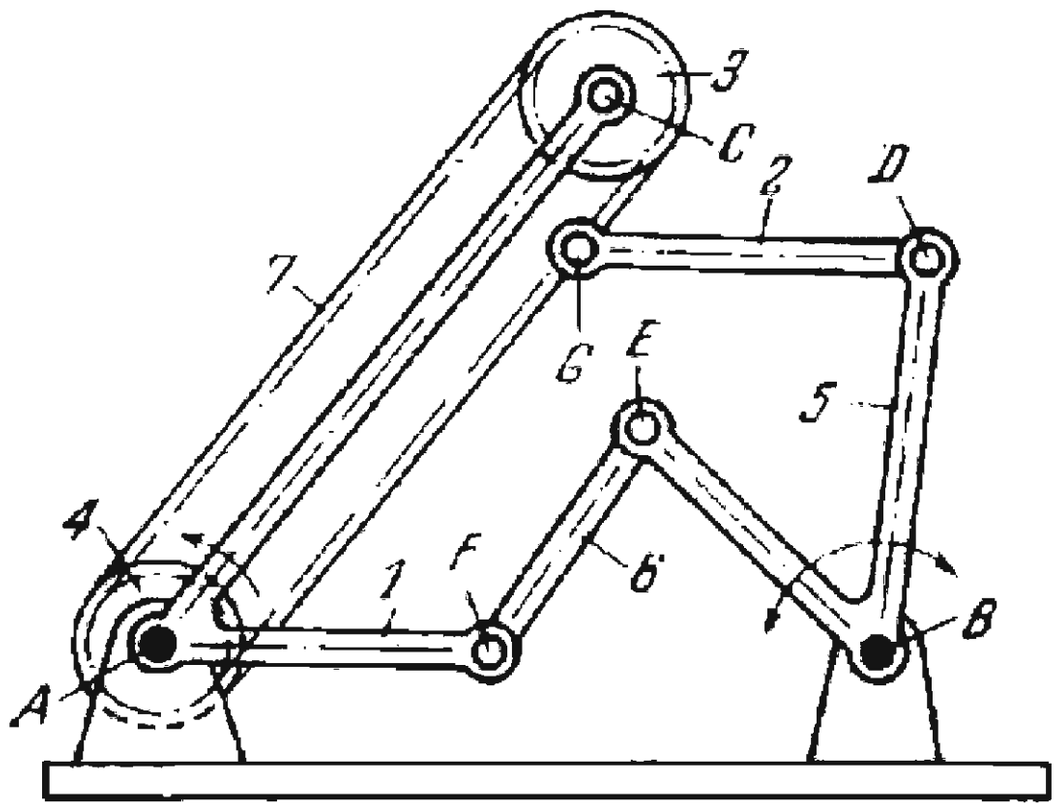
Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *D* to pulley *4* and to links *2* and *6*. Flexible link *8* runs over pulleys *4* and *7*, of equal diameter, and is connected by turning pairs *G* to links *3* and *5*. Pulley *7* is rigidly attached to the base. Links *2* and *6* are connected by turning pairs *F* and *E* to links *3* and *5*. When link *1* turns about axis *A*, links *2*, *3*, *5* and *6* have complex motions.

2076	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



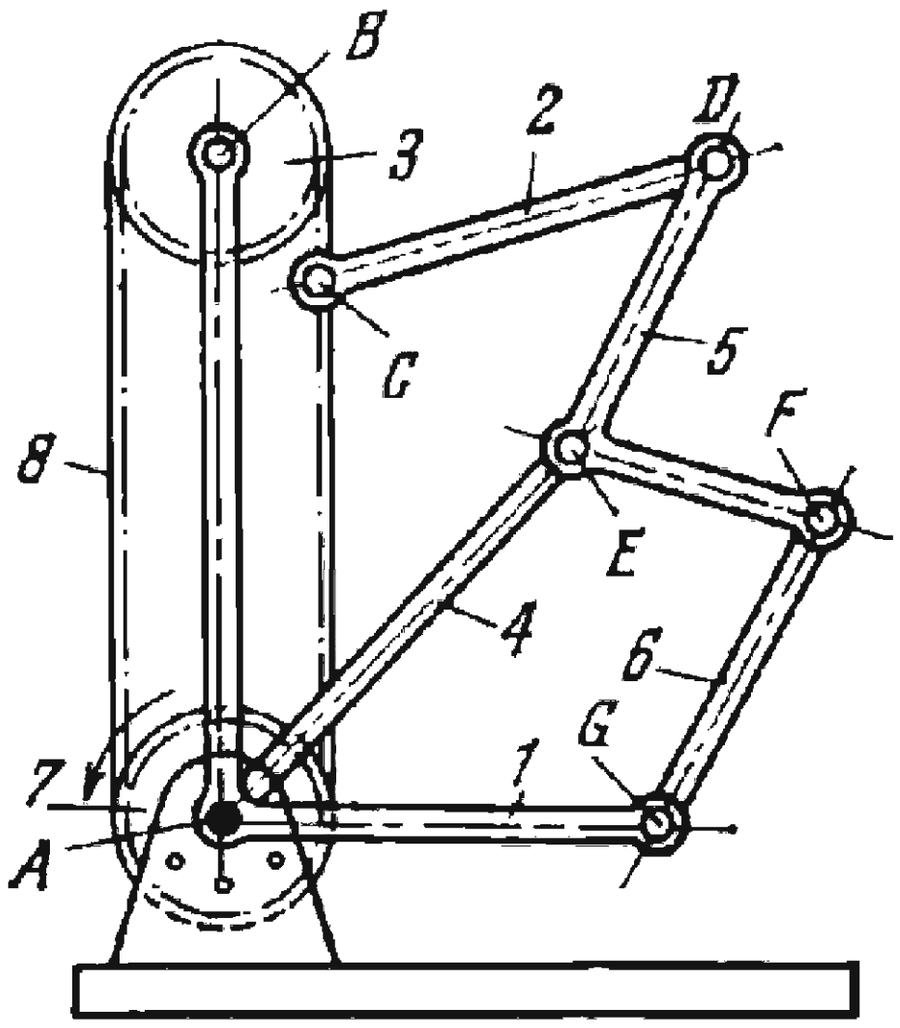
Link *5*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *F* and *E* to pulleys *6* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *G* to link *2*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *C* and *D* to links *4* and *2*. Link *4* is connected by turning pair *F* to link *5*. When link *1* turns about axis *A*, links *2* and *4* have complex motions and link *5* oscillates about axis *B*.

2077	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



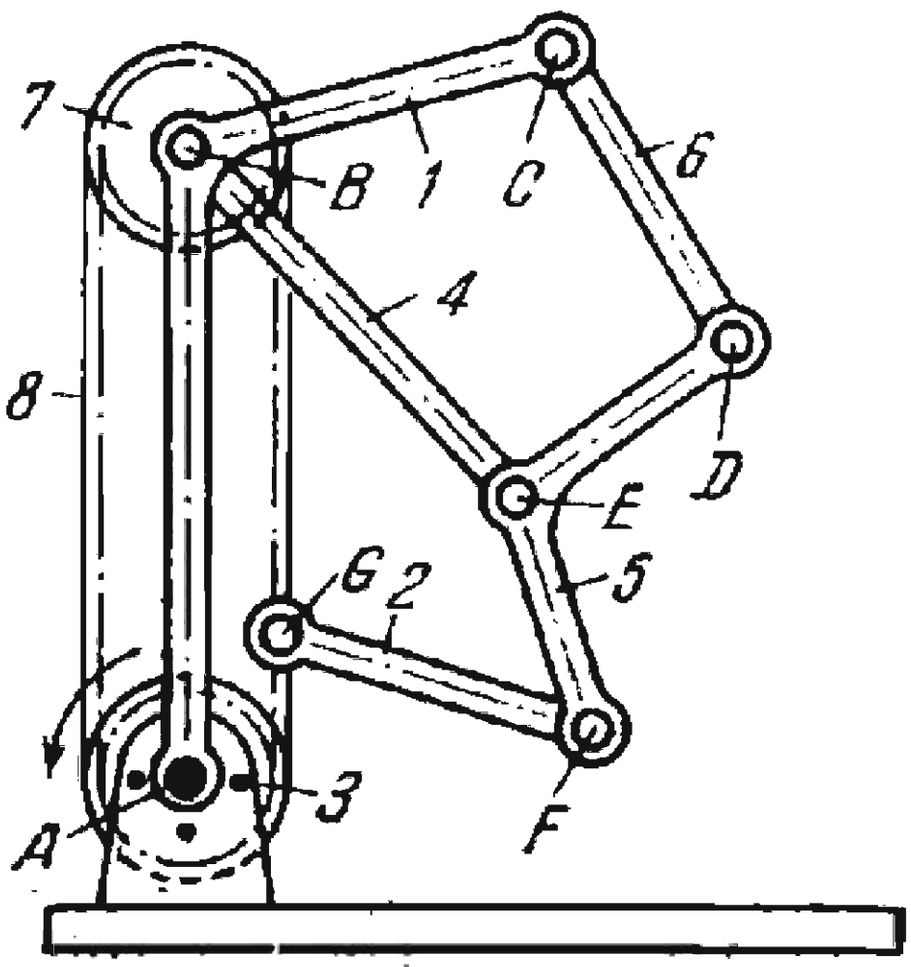
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *C* and *F* to pulley *3* and to link *6*. Flexible link *7* runs over pulleys *3* and *4*, of equal diameter, and is connected by turning pair *G* to link *2*. Link *5*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *D* and *E* to links *2* and *6*. When link *1* turns about axis *A*, links *2* and *6* have complex motions and link *5* oscillates about axis *B*.

2078	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



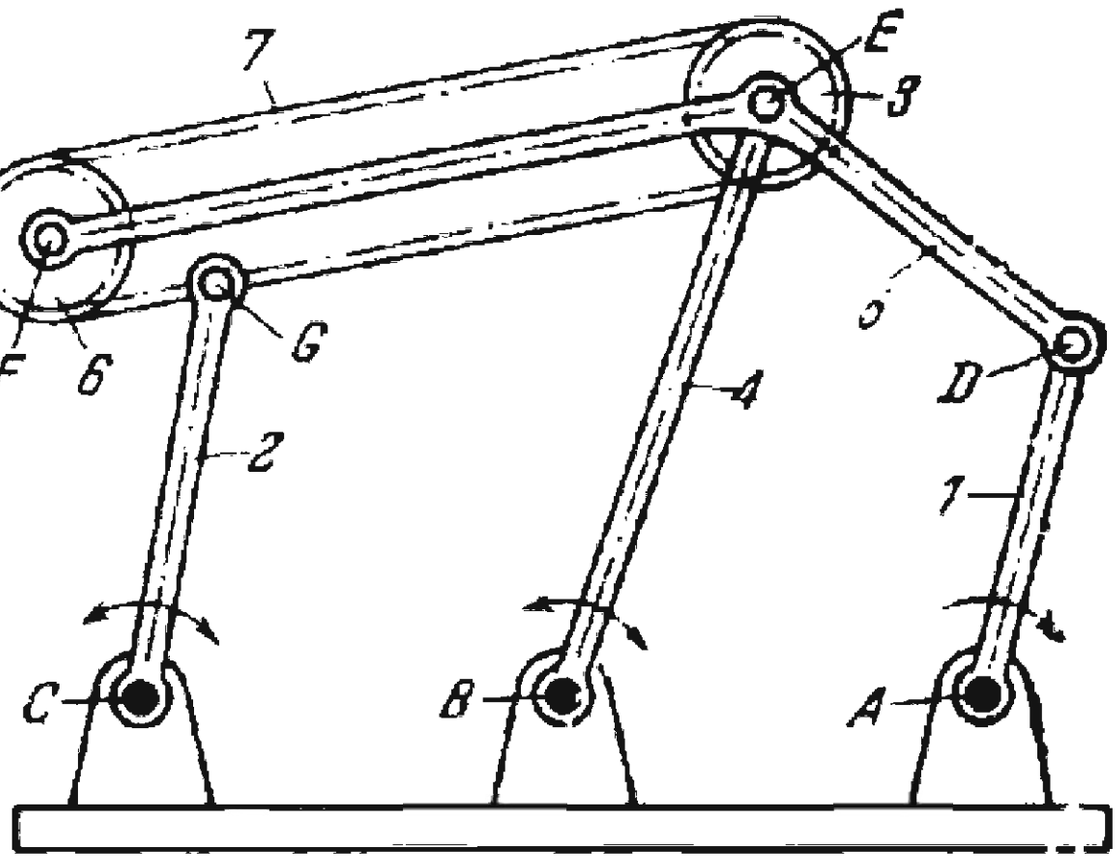
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *G* to pulley *3* and to link *6*. Flexible link *8* runs over pulleys *3* and *7*, of equal diameter, and is connected by turning pair *C* to link *2*. Pulley *7* is rigidly attached to the base. Link *5*, designed as a bent lever, is connected by turning pairs *D*, *E* and *F* to links *2*, *4* and *6*. Link *4* is connected by turning pair *A* to link *1*. When link *1* turns about axis *A*, links *2*, *4*, *5* and *6* have complex motions.

2079	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



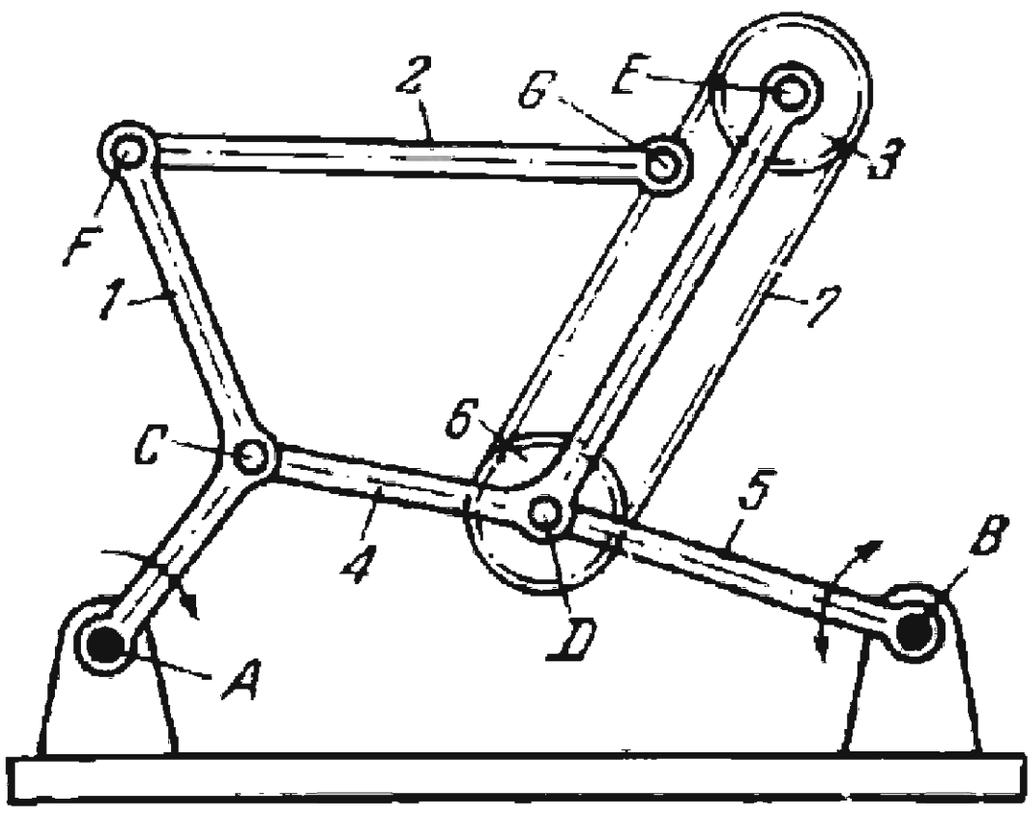
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to link *6*. Flexible link *8* runs over pulleys *3* and *7*, of equal diameter, and is connected by turning pair *G* to link *2*. Pulley *3* is rigidly attached to the base. Link *5*, designed as a bent lever, is connected by turning pairs *D*, *E* and *F* to links *6*, *4* and *2*. Link *4* is connected by turning pair *B* to link *1*. When link *1* turns about axis *A*, links *2*, *4*, *5* and *6* have complex motions.

2080	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



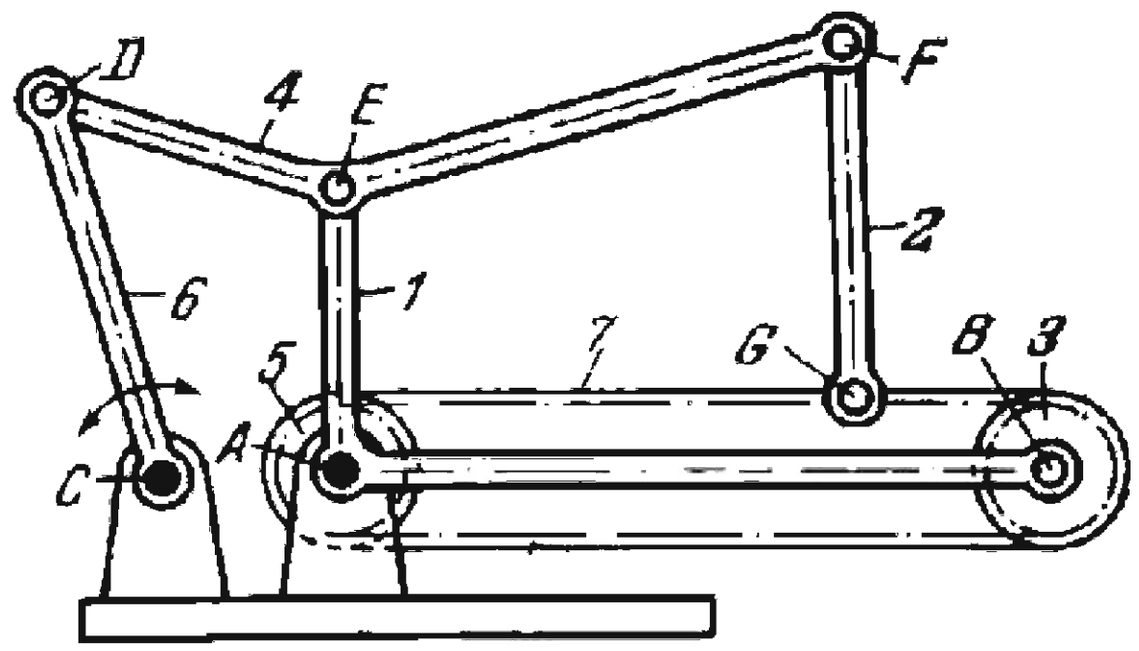
Link 5, designed as a bent lever, is connected by turning pairs *D*, *E* and *F* to link *1* and to pulleys *3* and *6*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *G* to link *2*. Link *4* turns about fixed axis *B* and is connected by turning pair *E* to link *5*. Links *1* and *2* turn about fixed axes *A* and *C*. When link *1* turns about axis *A*, link *5* has a complex motion and links *2* and *4* oscillate about axes *C* and *B*.

2081	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



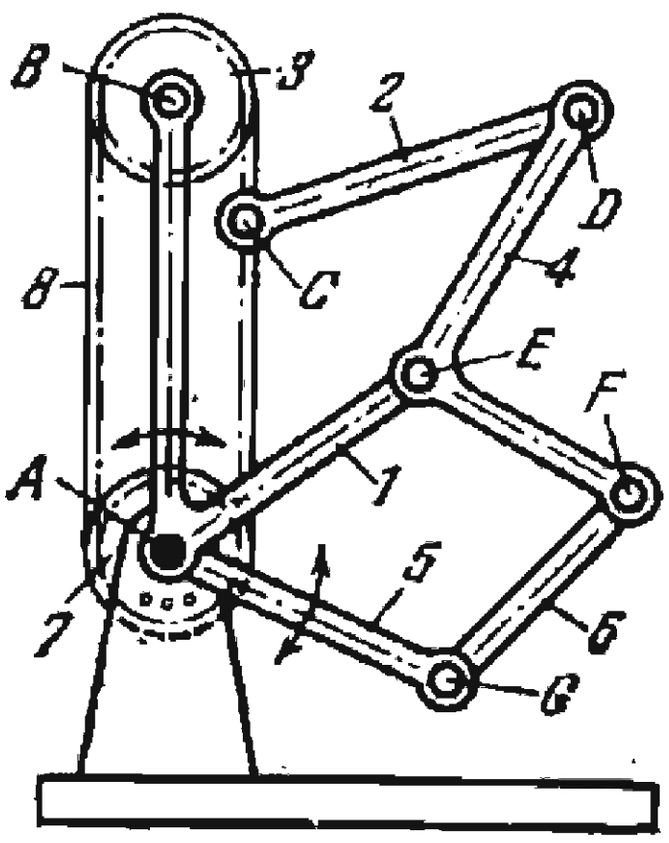
Link *4*, designed as a bent lever, is connected by turning pairs *C*, *D* and *E* to link *1* and to pulleys *6* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *G* to link *2*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *F* to link *2*. Link *5* turns about fixed axis *B* and is connected by turning pair *D* to link *4*. When link *1* turns about axis *A*, links *2* and *4* have complex motions and link *5* oscillates about axis *B*.

2082	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



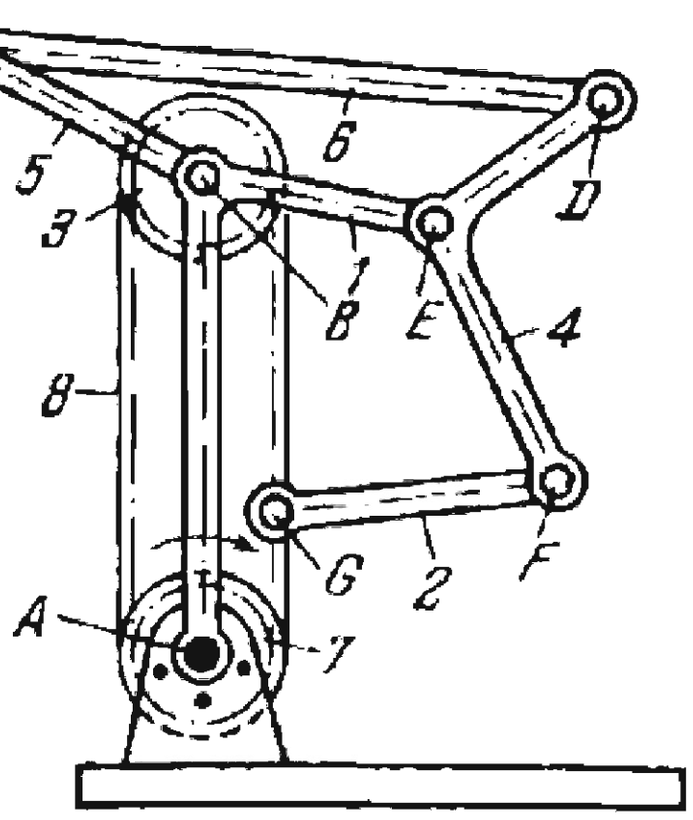
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B*, *A* and *E* to pulleys *3* and *5*, of equal diameter, and to link *4*. Flexible link *7* runs over the pulleys and is connected by turning pair *G* to link *2*. Link *4*, designed as a bent lever, is connected by turning pairs *F* and *D* to links *2* and *6*. Link *6* turns about fixed axis *C*. When link *1* turns about axis *A*, links *2* and *4* have complex motions and link *6* oscillates about axis *C*.

2083	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



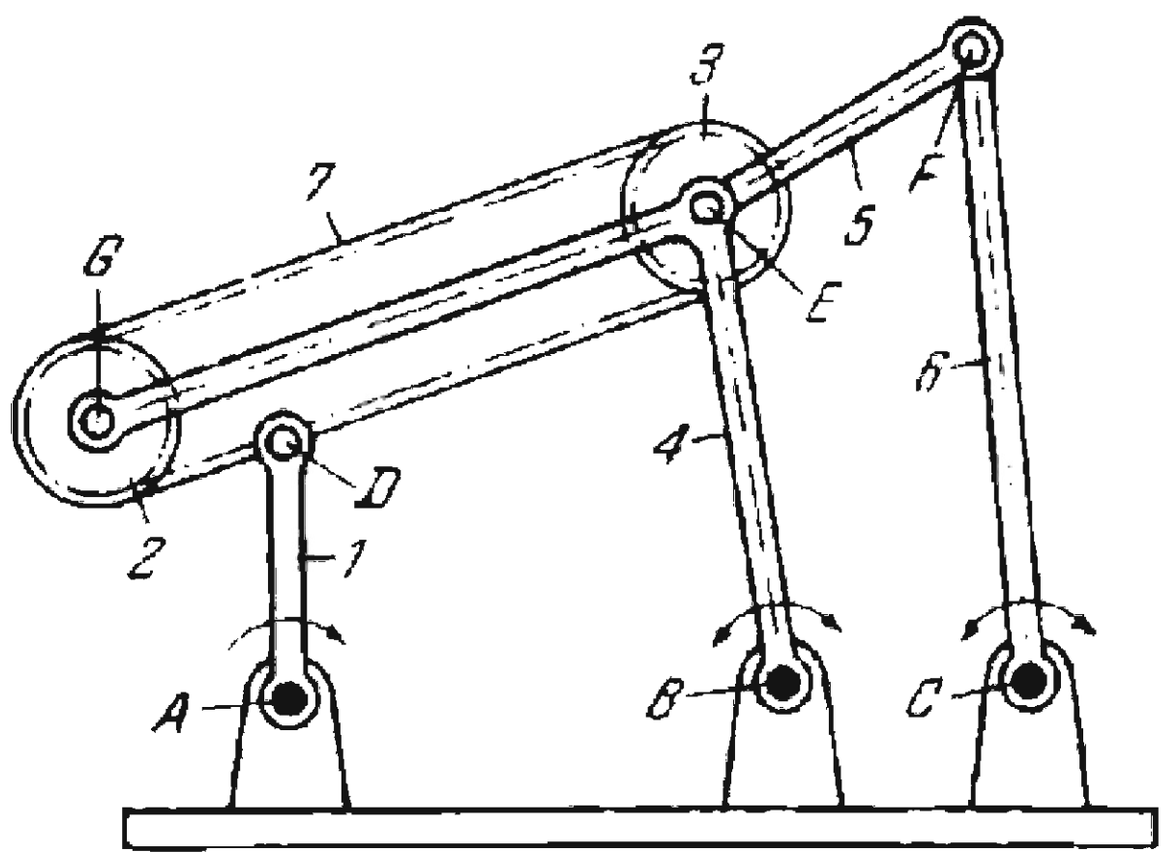
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *E* to pulley *3* and to link *4*. Flexible link *8* runs over pulleys *3* and *7*, of equal diameter, and is connected by turning pair *C* to link *2*. Pulley *7* is rigidly attached to the base. Link *4*, designed as a bent lever, is connected by turning pairs *D* and *F* to links *2* and *6*. Link *5* turns about axis *A* and is connected by turning pair *G* to link *6*. When link *1* turns about axis *A*, links *2*, *4* and *6* have complex motions and link *5* oscillates about axis *A*.

2084	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



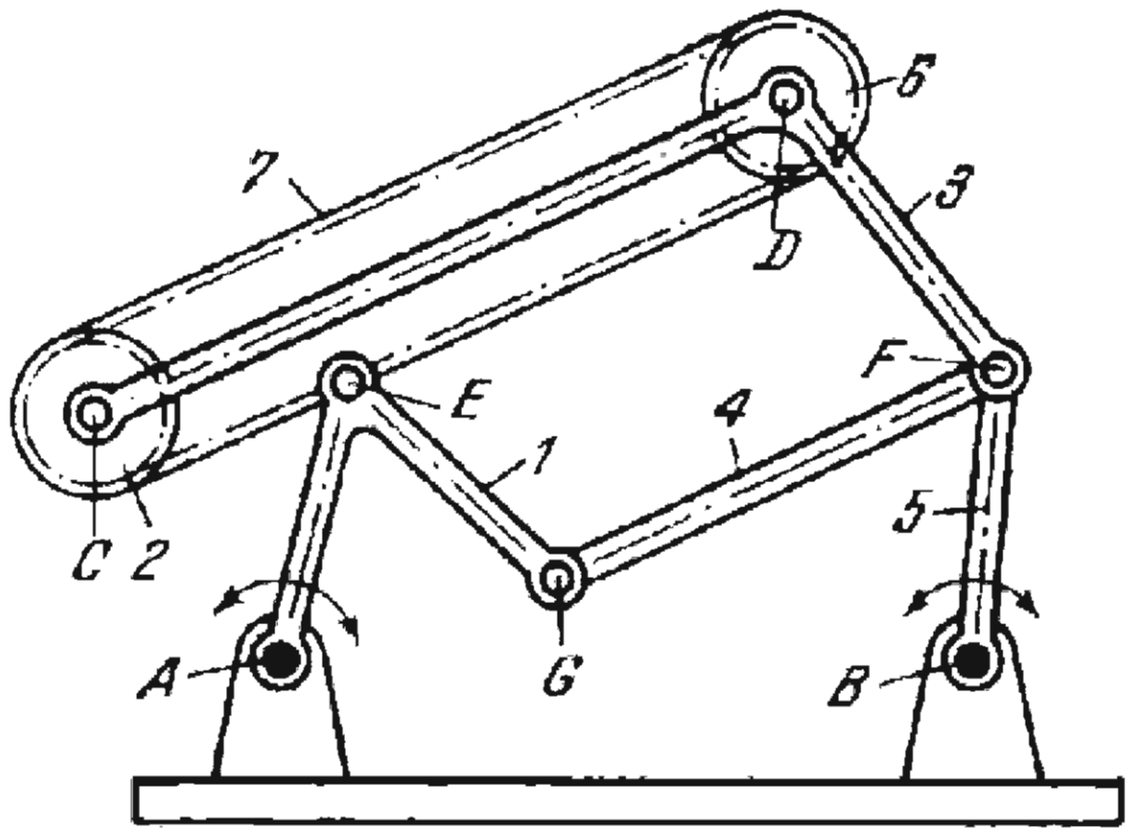
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *E* to pulley *3* and to link *4*. Flexible link *8* runs over pulleys *3* and *7*, of equal diameter, and is connected by turning pair *G* to link *2*. Pulley *7* is rigidly attached to the base. Link *4*, designed as a bent lever, is connected by turning pairs *D* and *F* to links *6* and *2*. Link *5* is connected by turning pairs *C* and *B* to links *6* and *1*. When link *1* turns about axis *A*, links *2*, *4*, *5* and *6* have complex motions.

2085	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



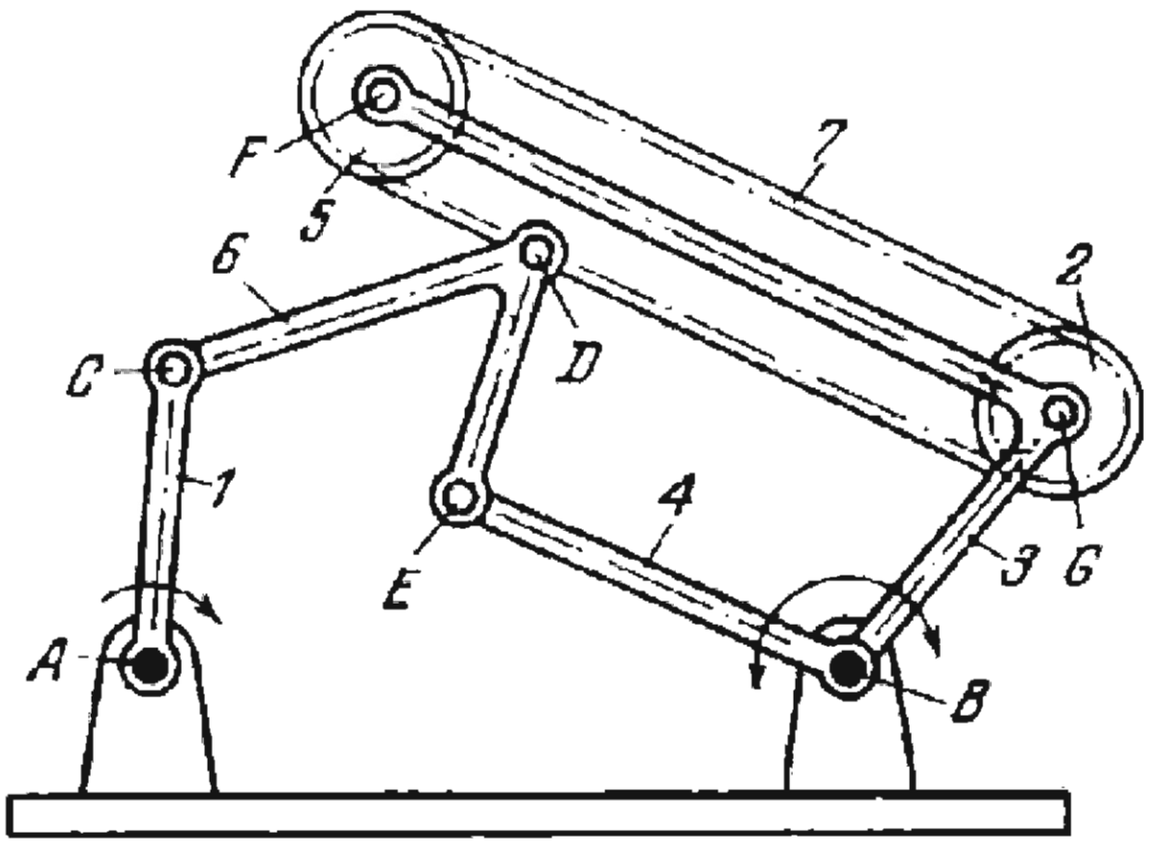
Link *4*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *G* and *E* to pulleys *2* and *3*, of equal diameter. Flexible link *7* runs over the pulleys and is connected to turning pair *D* to link *1*. Link *5* is connected by turning pairs *E* and *F* to links *4* and *6*. Links *1* and *6* turn about fixed axes *A* and *C*. When link *1* turns about axis *A*, link *5* has a complex motion and links *4* and *6* oscillate about axes *B* and *C*.

2086	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



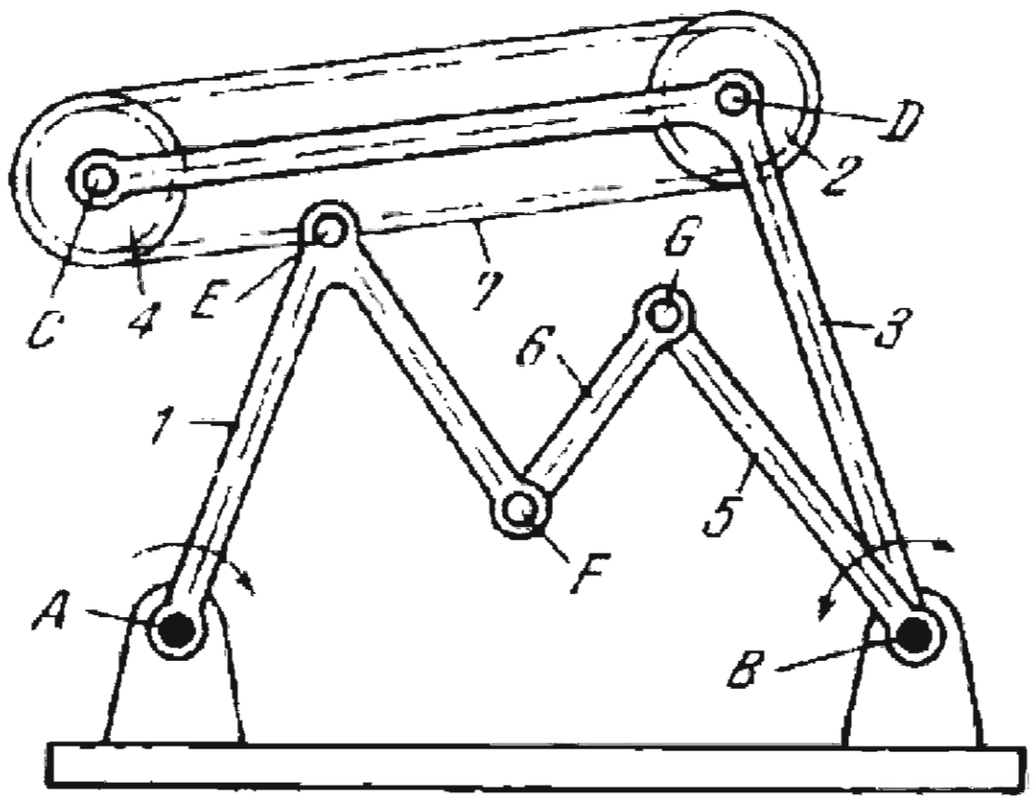
Link *3*, designed as a bent lever, is connected by turning pairs *C*, *D* and *F* to pulleys *2* and *6*, of equal diameter, and to links *4* and *5*. Flexible link *7* runs over the pulleys and is connected by turning pair *E* to link *1*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *G* to link *4*. Link *5* turns about fixed axis *B*. When link *1* turns about axis *A*, links *3* and *4* have complex motions and link *5* oscillates about axis *B*.

2087	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



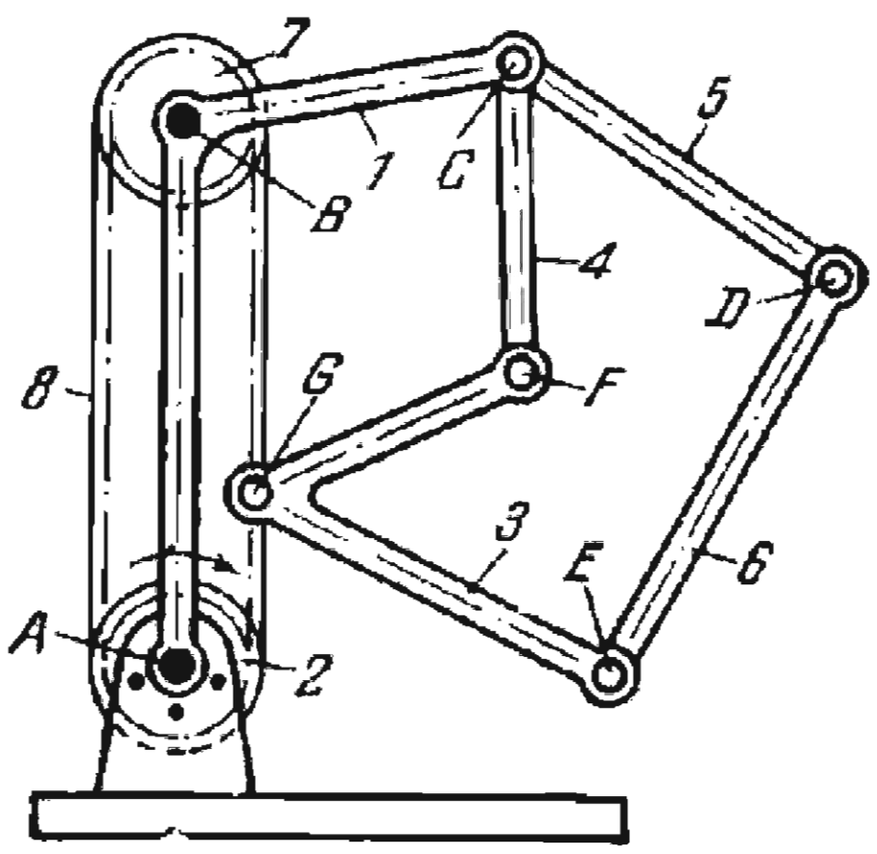
Link *3*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *G* and *F* to pulleys *2* and *5*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *D* to link *6*. Link *6*, designed as a bent lever, is connected by turning pairs *C* and *E* to links *1* and *4* which turn about fixed axes *A* and *B*. When link *1* turns about axis *A*, link *6* has a complex motion and links *4* and *3* oscillate about axis *B*.

2088	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



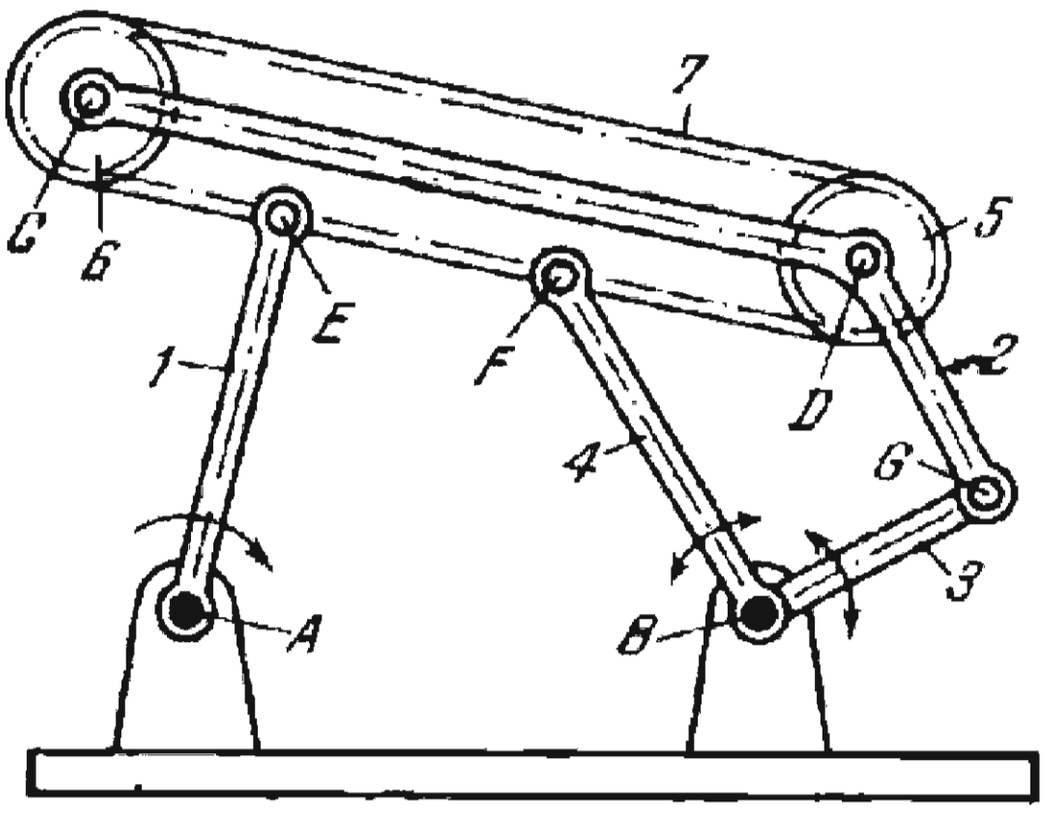
Link *3*, designed as a bent lever, turns about fixed axis *B* and is connected by turning pairs *D* and *C* to pulleys *2* and *4*, of equal diameter. Flexible link *7* runs over the pulleys and is connected by turning pair *E* to link *1*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pair *F* to link *6*. Link *5* turns about axis *B* and is connected by turning pair *G* to link *6*. When link *1* turns about axis *A*, link *6* has a complex motion, and links *3* and *5* oscillate about axis *B*.

2089	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



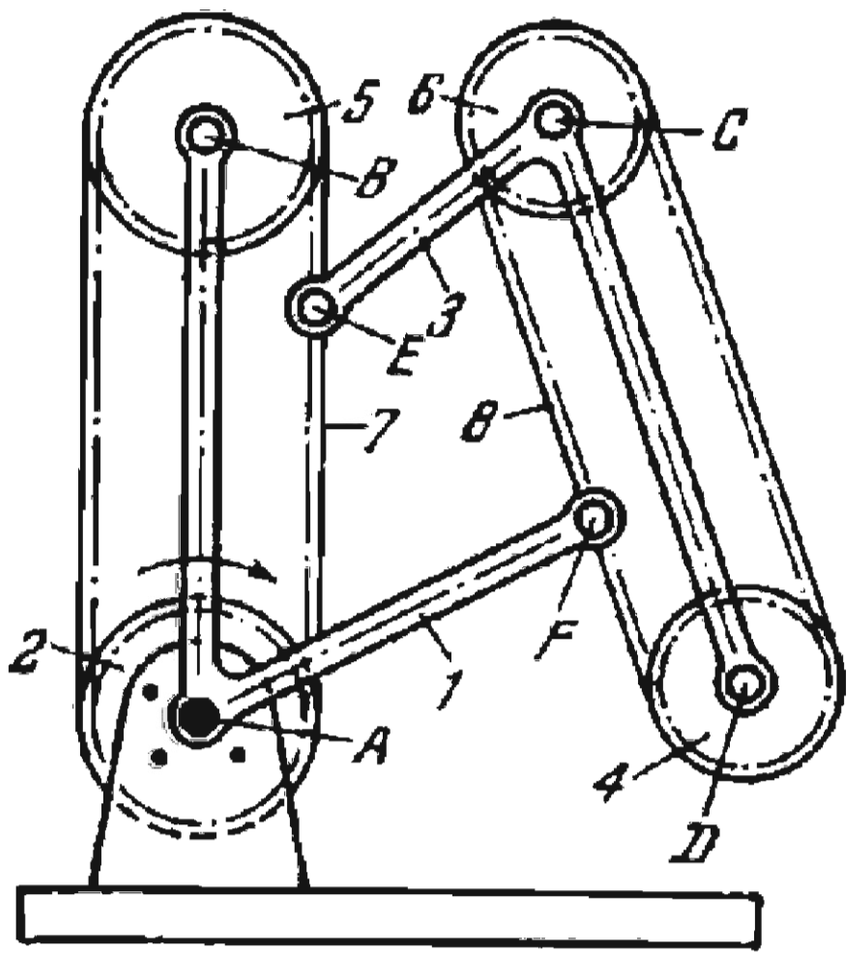
Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulley *7* and to links *4* and *5*. Flexible link *8* runs over pulleys *2* and *7*, of equal diameter, and is connected by turning pair *G* to link *3*. Pulley *2* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *F* and *E* to links *4* and *6*. Links *5* and *6* are connected together by turning pair *D*. When link *1* turns about axis *A*, links *3*, *4*, *5* and *6* have complex motions.

2090	HAIN LINKWORK SATELLITE MECHANISM WITH A FLEXIBLE LINK	FL Sa



Link *2*, designed as a bent lever, is connected by turning pairs *C*, *D* and *G* to pulleys *6* and *5*, of equal diameter, and to link *3*. Flexible link *7* runs over the pulleys and is connected by turning pairs *E* and *F* to links *1* and *4*. Links *1*, *4* and *3* turn about fixed axes *A* and *B*. When link *1* turns about axis *A*, link *2* has a complex motion and links *3* and *4* oscillate about axis *B*.

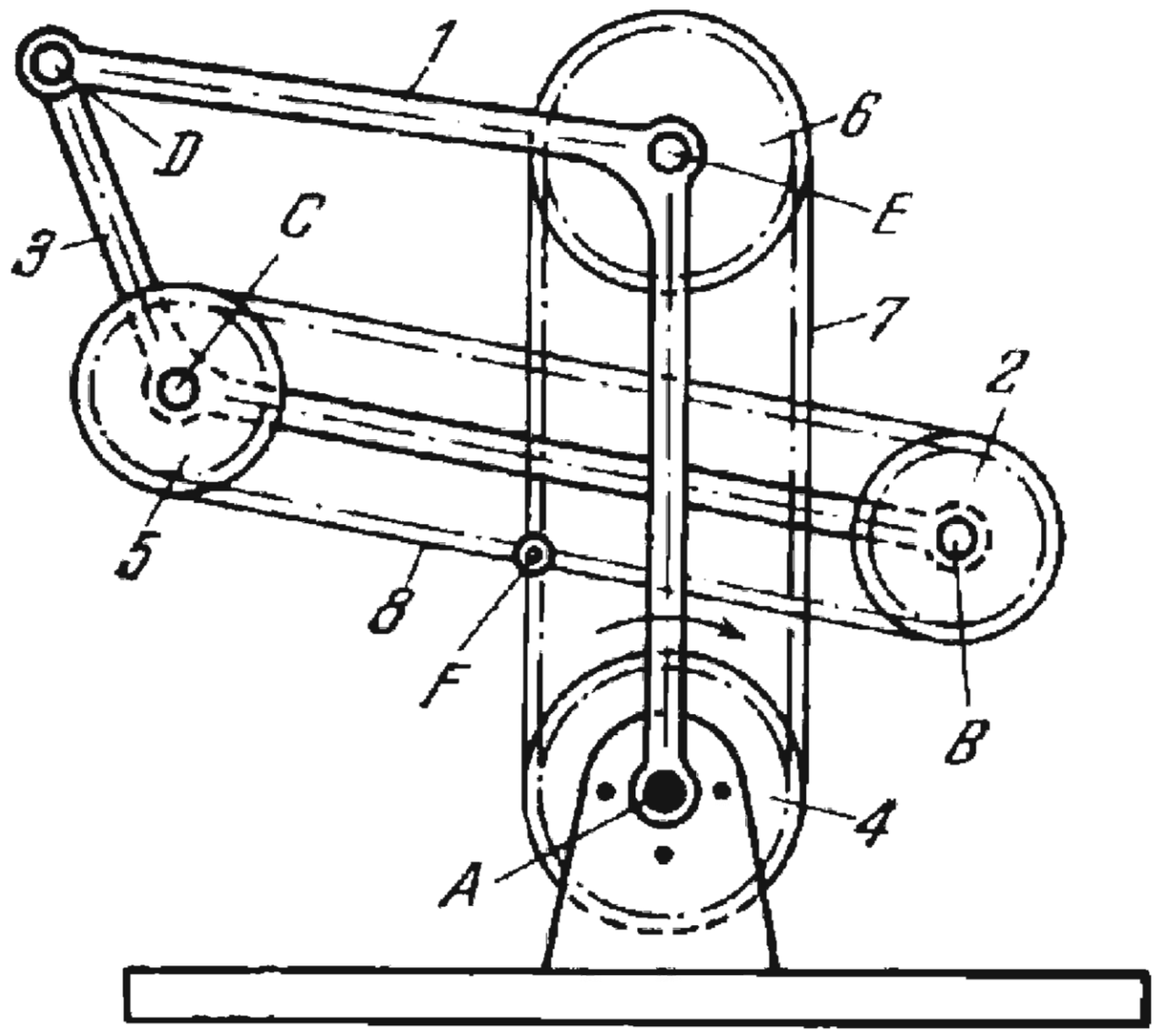
2091	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *6*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *F* to pulley *5* and to flexible link *8*. Flexible link *7* runs over pulleys *2* and *5* and is connected by turning pair *E* to link *3*. Pulley *2* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *C* and *D* to pulleys *6* and *4*. Flexible link *8* runs over pulleys *4* and *6*. When link *1* turns about axis *A*, pulleys *4* and *6* rotate about axes *D* and *C*, imparting a complex motion to link *3*.

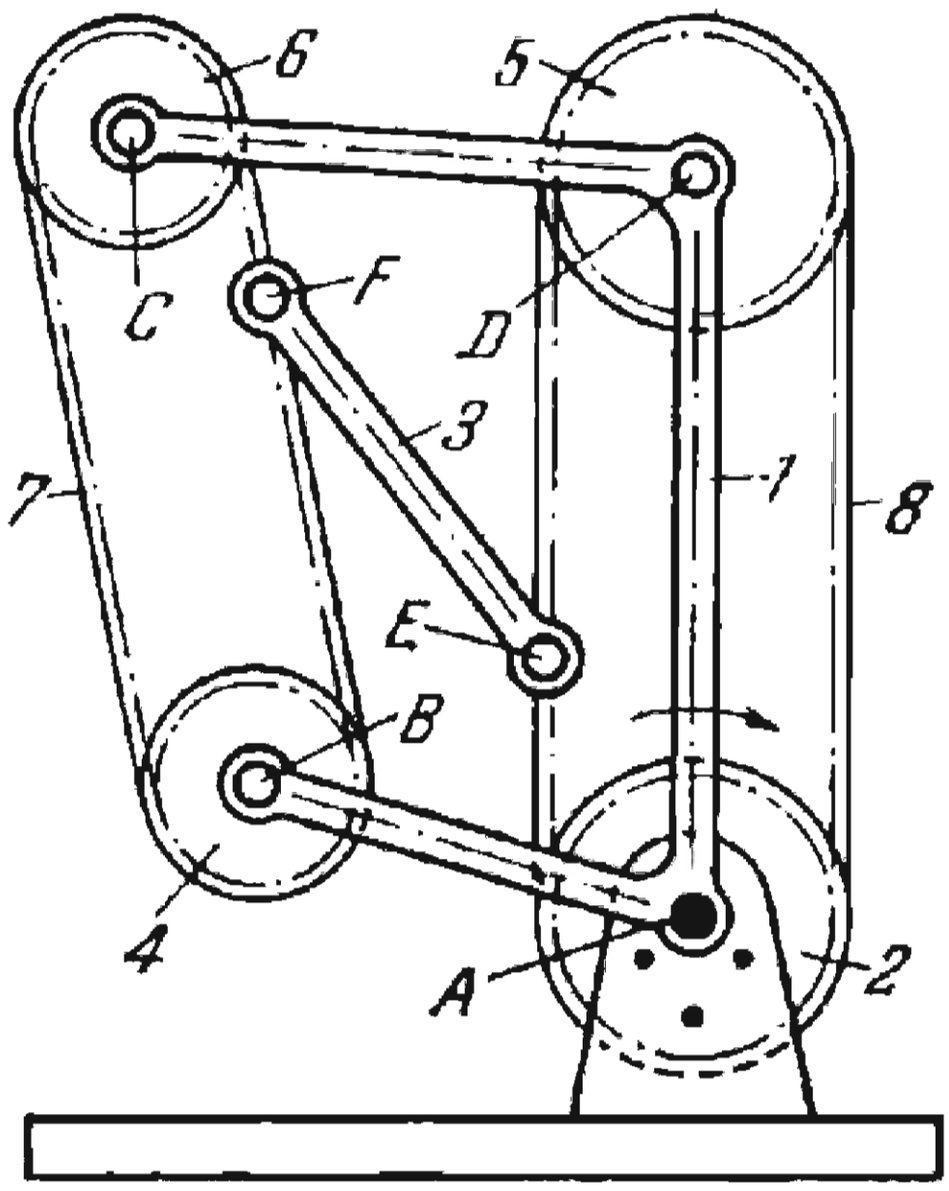
M

HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS



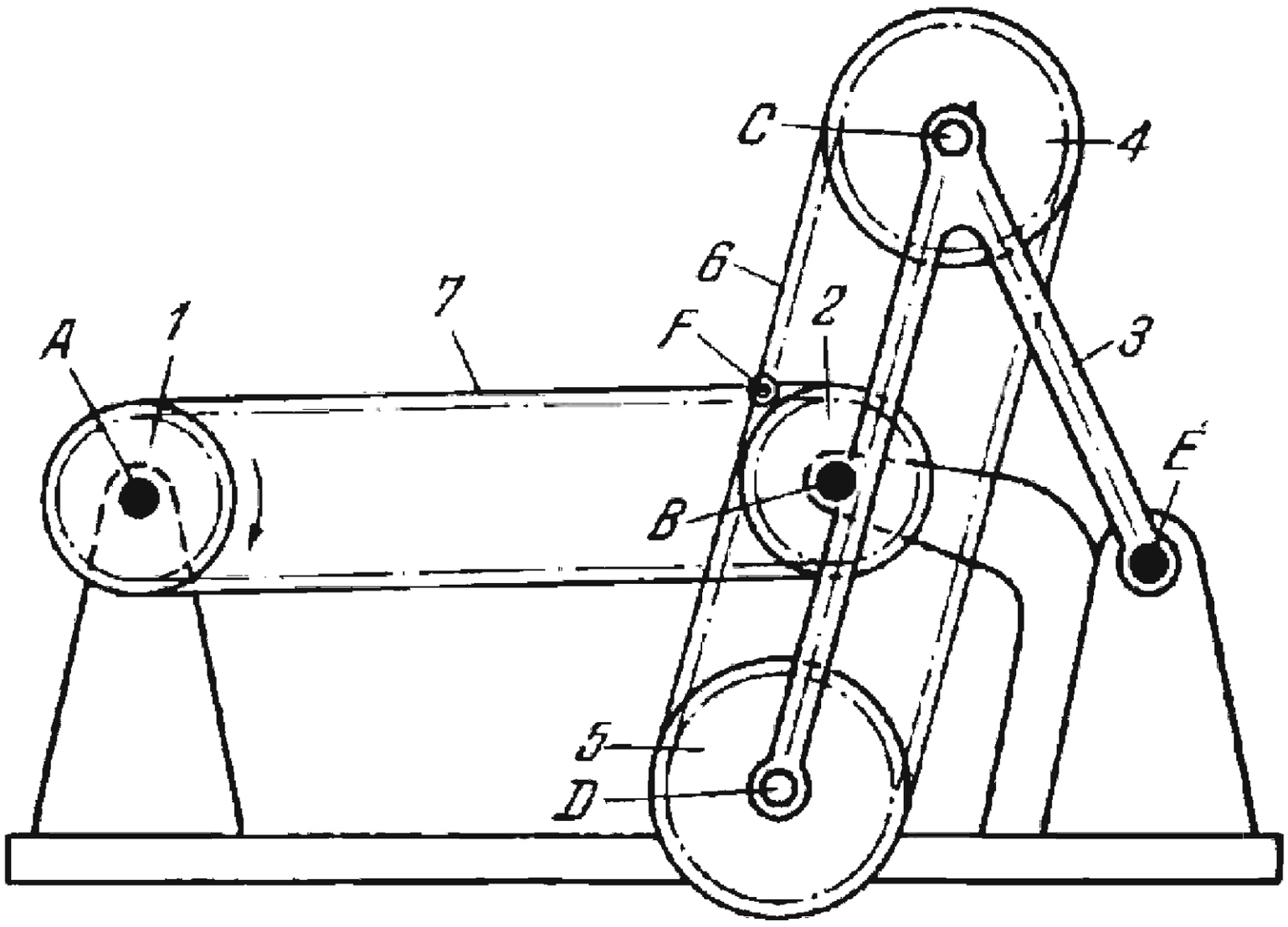
Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *6*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *E* and *D* to pulley *6* and to link *3*. Flexible link *7* runs over pulleys *4* and *6*. Pulley *4* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *B* and *C* to pulleys *2* and *5*. Flexible link *8* runs over pulleys *2* and *5*. Flexible links *7* and *8* are connected together by turning pair *F*. When link *1* turns about axis *A*, pulleys *2* and *5* rotate about axes *B* and *C*, imparting a complex motion to link *3*.

2093	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



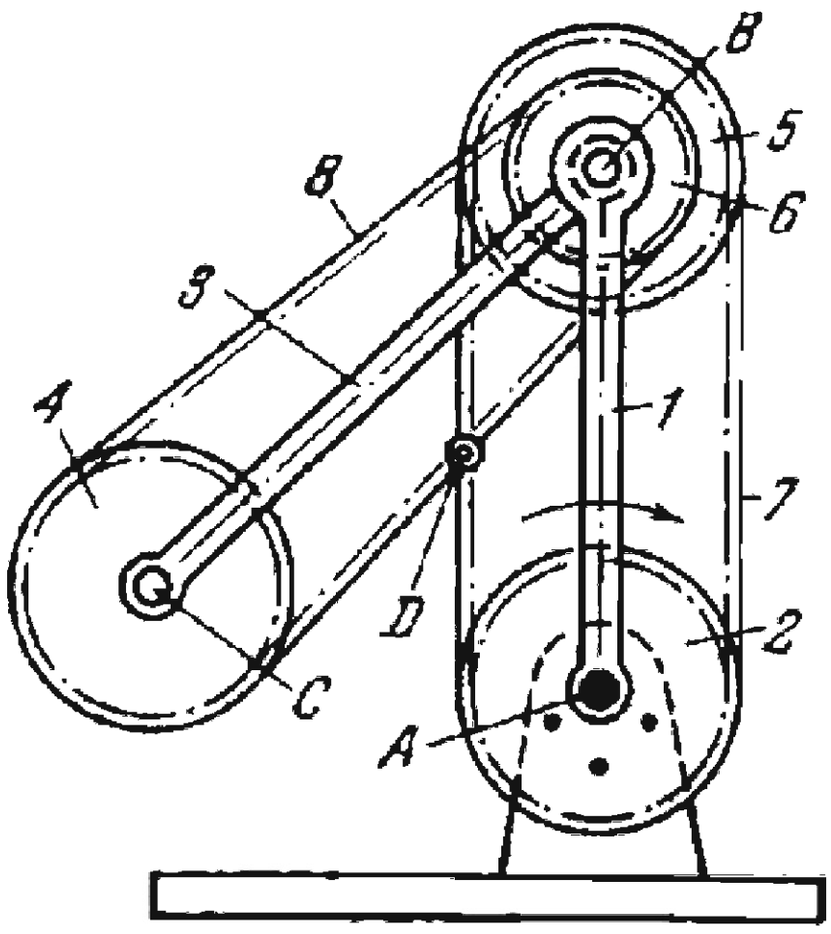
Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *6*. Link *1*, designed as a complex lever, turns about fixed axis *A* and is connected by turning pairs *B*, *C* and *D* to pulleys *4*, *6* and *5*. Flexible link *8* runs over pulleys *2* and *5*. Pulley *2* is rigidly attached to the base. Flexible link *7* runs over pulleys *4* and *6*. Link *3* is connected by turning pairs *E* and *F* to flexible links *8* and *7*. When link *1* turns about axis *A*, pulleys *4* and *6* rotate about axes *B* and *C*, imparting a complex motion to link *3*.

2094	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



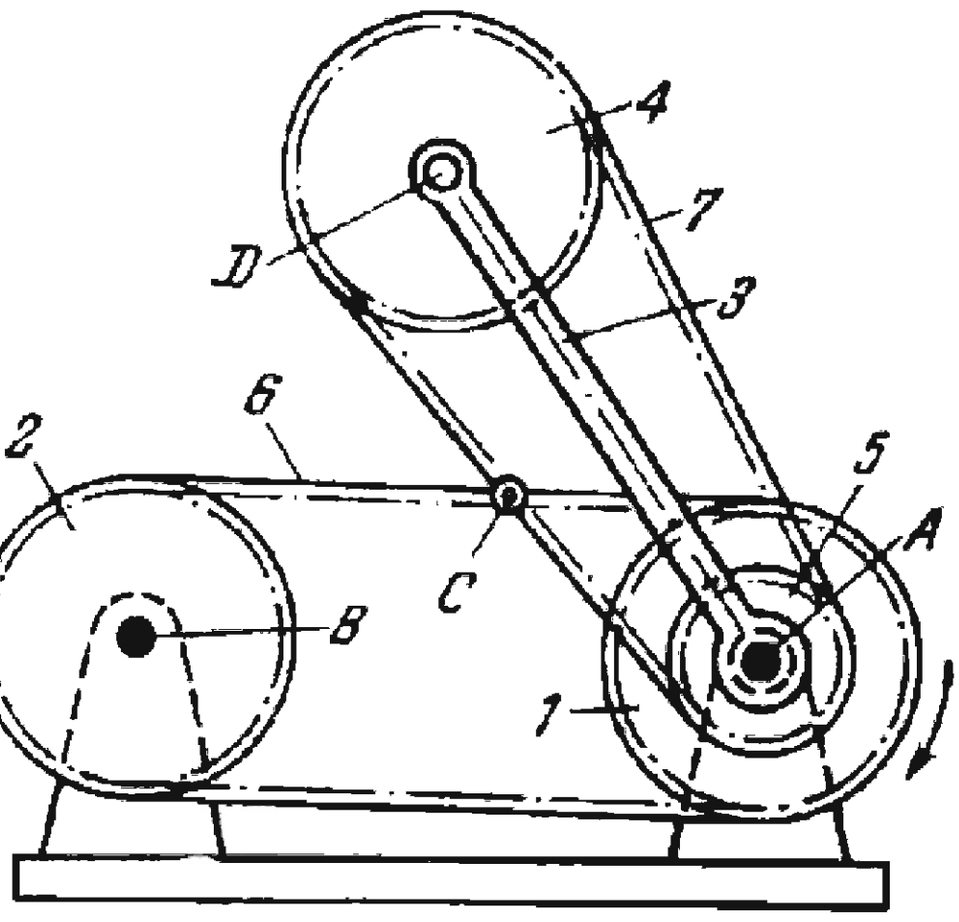
Pulleys *1* and *2* are of equal diameter, as are pulleys *4* and *5*. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Link *3*, designed as a bent lever, turns about fixed axis *E* and is connected by turning pairs *C* and *D* to pulleys *4* and *5*. Flexible link *6* runs over pulleys *4* and *5* and is connected by turning pair *F* to flexible link 7. When pulley *1* rotates about axis *A*, pulleys *4* and *5* rotate about axes *C* and *D*, imparting oscillating motion to link *3* about axis *E*.

2095	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



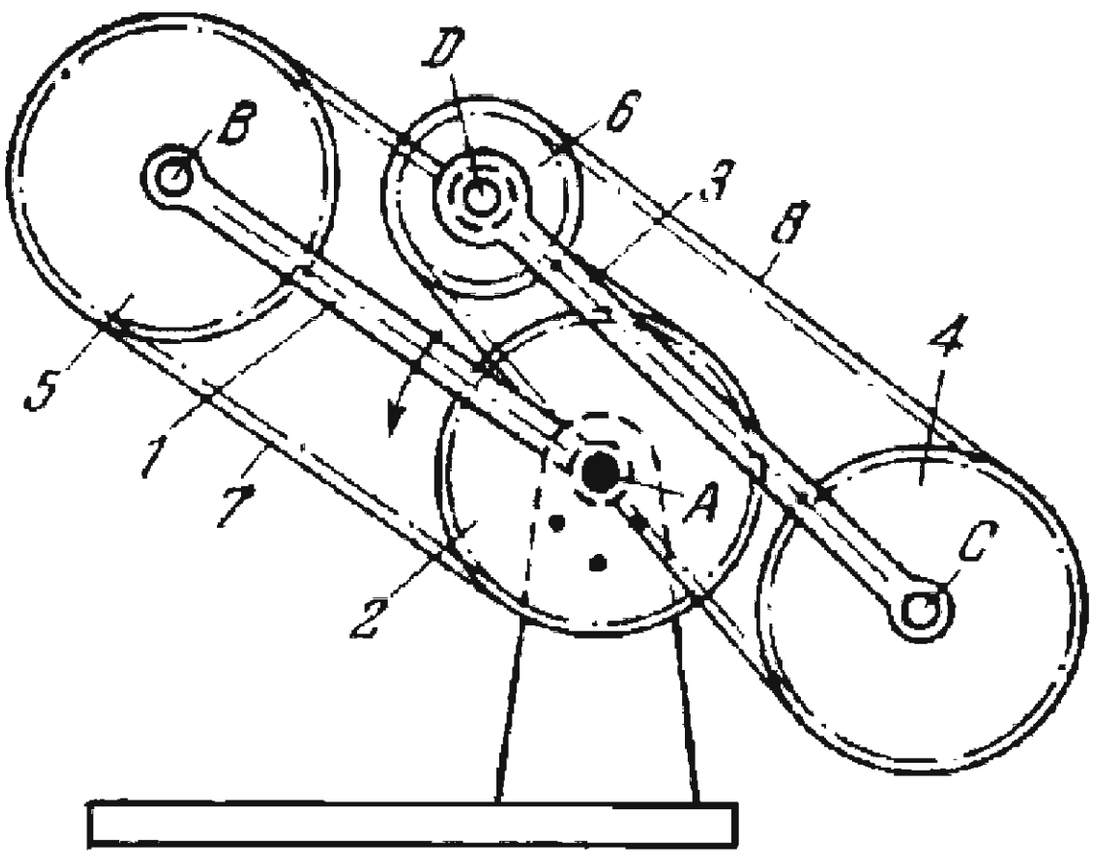
Link *1* turns about fixed axis *A* and is connected by turning pair *B* to pulley *5*. Flexible link *7* runs over pulleys *2* and *5*, of equal diameter. Pulley *2* is rigidly attached to the base. Link *3* is connected by turning pairs *B* and *C* to pulleys *6* and *4*. Flexible link *8* runs over pulleys *4* and *6* and is connected by turning pair *D* to flexible link *7*. When link *1* turns about axis *A*, pulleys *4* and *6* rotate about axes *C* and *B*, imparting a complex motion to link 3.

2096	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



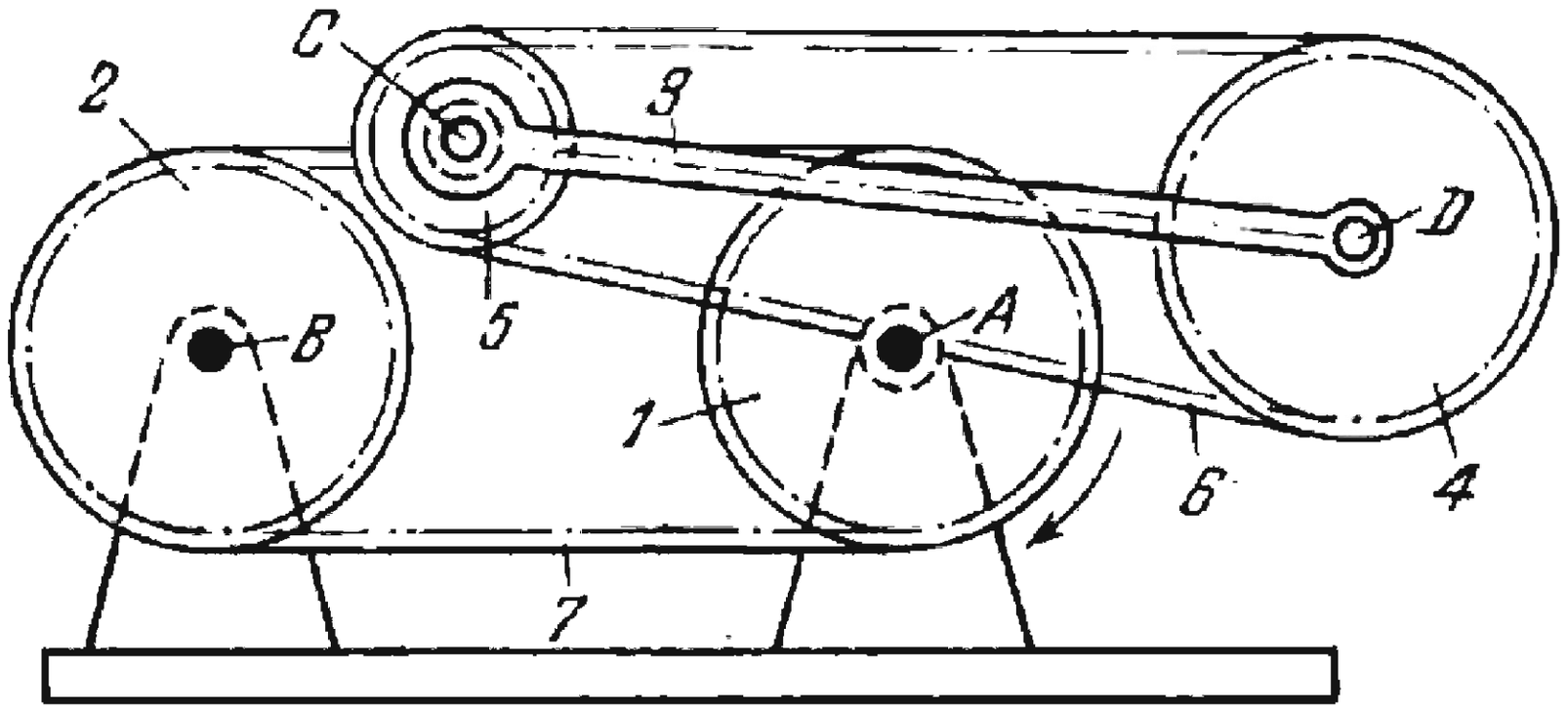
Pulleys *1* and *2* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *6*, rotates pulley *2* about fixed axis *B*. Link *3* turns about axis *A* and is connected by turning pair *D* to pulley *4*. Flexible link *7* runs over pulleys *4* and *5* and is connected by turning pair *C* to flexible link *6*. When pulley *1* rotates about axis *A*, pulleys *4* and *5* rotate about axes *D* and *A*, imparting oscillating motion to link *3* about axis *A*.

2097	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



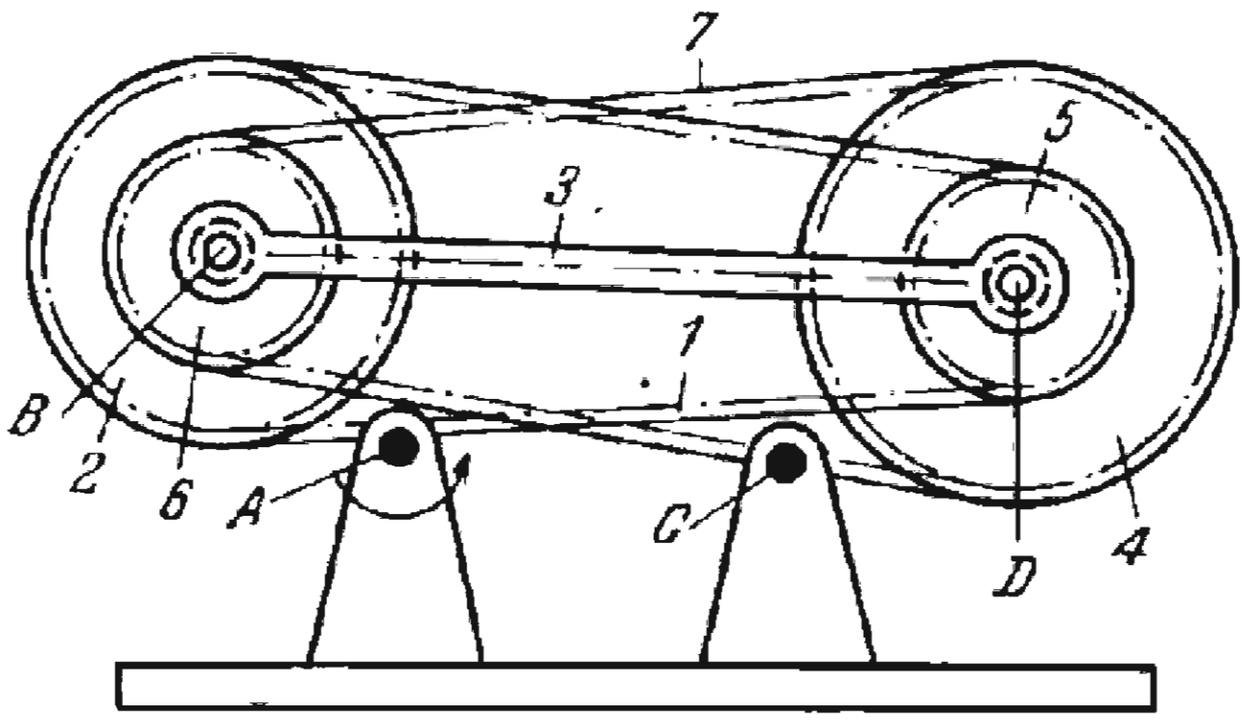
Pulleys *2*, *4* and *5* are of equal diameter. Link *1* rotates about fixed axis *A* and is connected by turning pair *B* to pulley *5*. Flexible link *7* runs over pulleys *2* and *5*. Pulley *2* is rigidly attached to the base. Flexible link *7* is connected by turning pair *D* to pulley *6*. Link *3* is connected by turning pairs *D* and *C* to pulleys *6* and *4*. Flexible link *8* runs over pulleys *4* and *6* and turns about axis *A*. When link *1* turns about axis *A*, pulleys *4* and *6* rotate about axes *C* and *D*, imparting a complex motion to link *3*.

2098	HAIN LEVER-TYPE SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



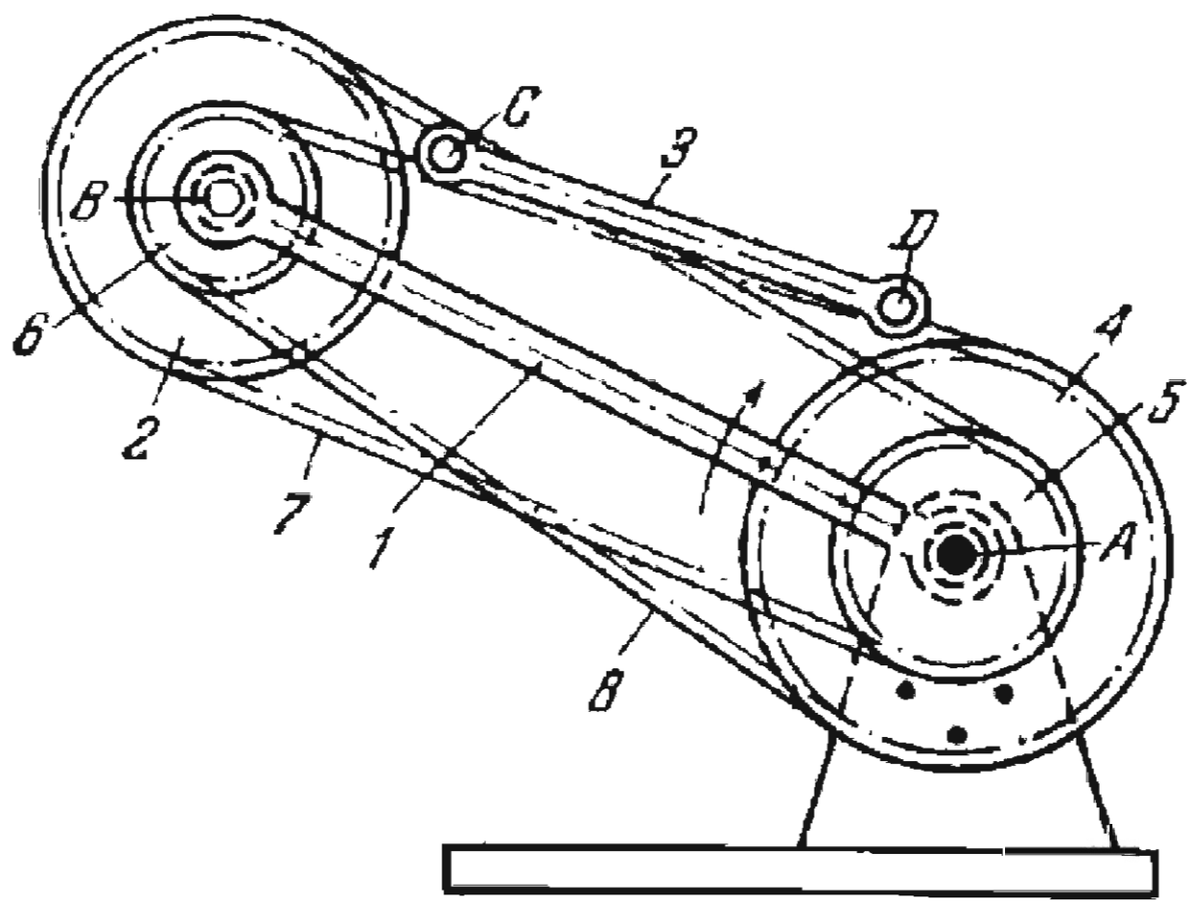
Pulleys *1*, *2* and *4* are of equal diameter. Pulley *1* rotates about fixed axis *A* and, through flexible link *7*, rotates pulley *2* about fixed axis *B*. Flexible link *7* is connected by turning pair *C* to pulley *5*. Link *3* is connected by turning pairs *C* and *D* to pulleys *5* and *4*. Flexible link *6* runs over pulleys *4* and *5* and turns about axis *A*. When pulley *1* rotates about axis *A*, pulleys *5* and *4* rotate about axes *C* and *D*, imparting a complex motion to link *3*.

2099	HAIN LEVER-TYPE SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



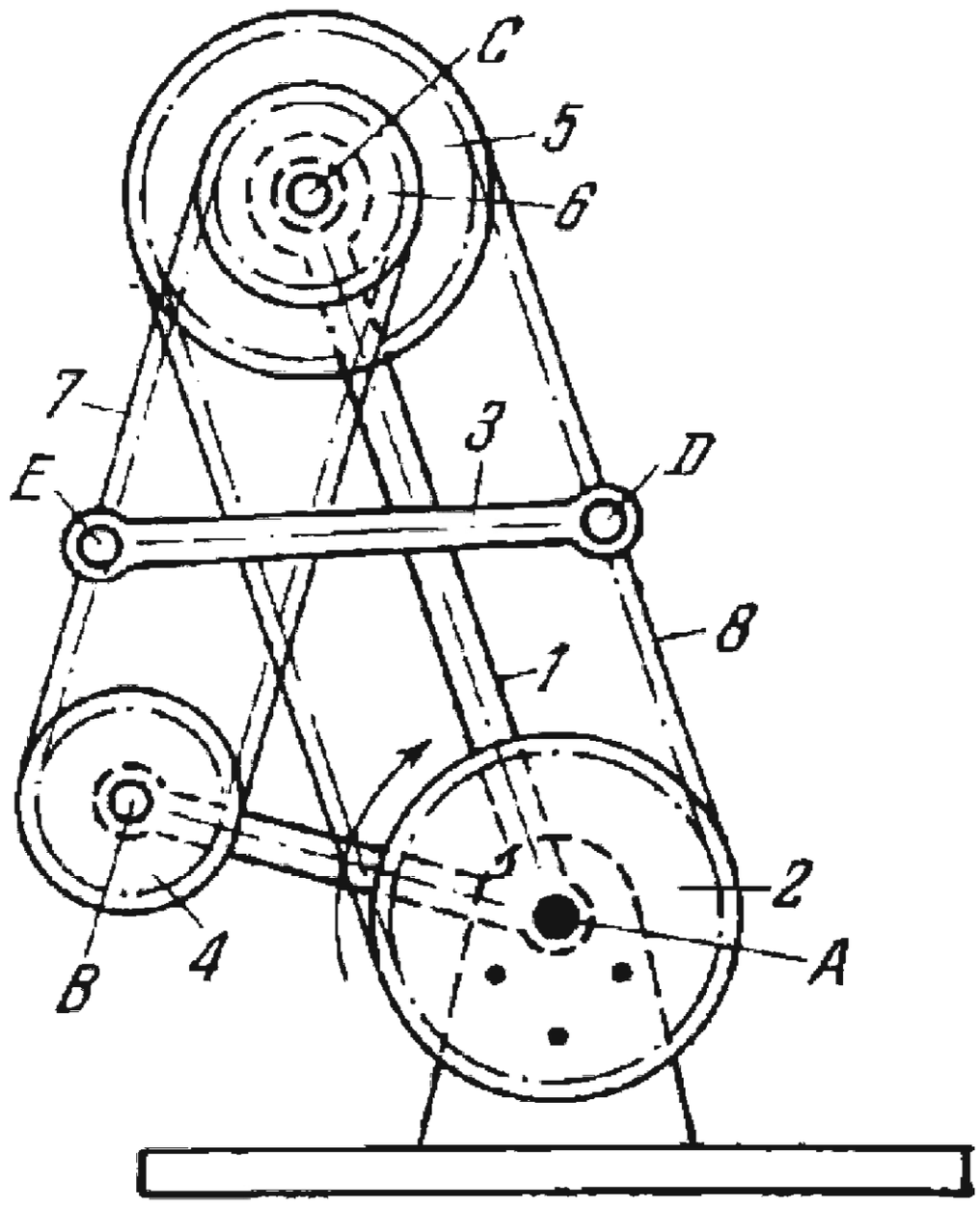
Flexible link *1* turns about fixed axis *A* and runs over pulleys *2* and *5* which rotate about axes *B* and *D*. Flexible link *7* turns about fixed axis *C* and runs over pulleys *4* and *6* which rotate about axes *D* and *B*. Link *3* is connected by turning pairs *B* and *D* to pulleys *2*, *6*, *5* and *4*. When flexible link *1* turns about axis *A*, pulleys *4* and *6* rotate about axes *D* and *B*, imparting a complex motion to link *3*.

2100	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



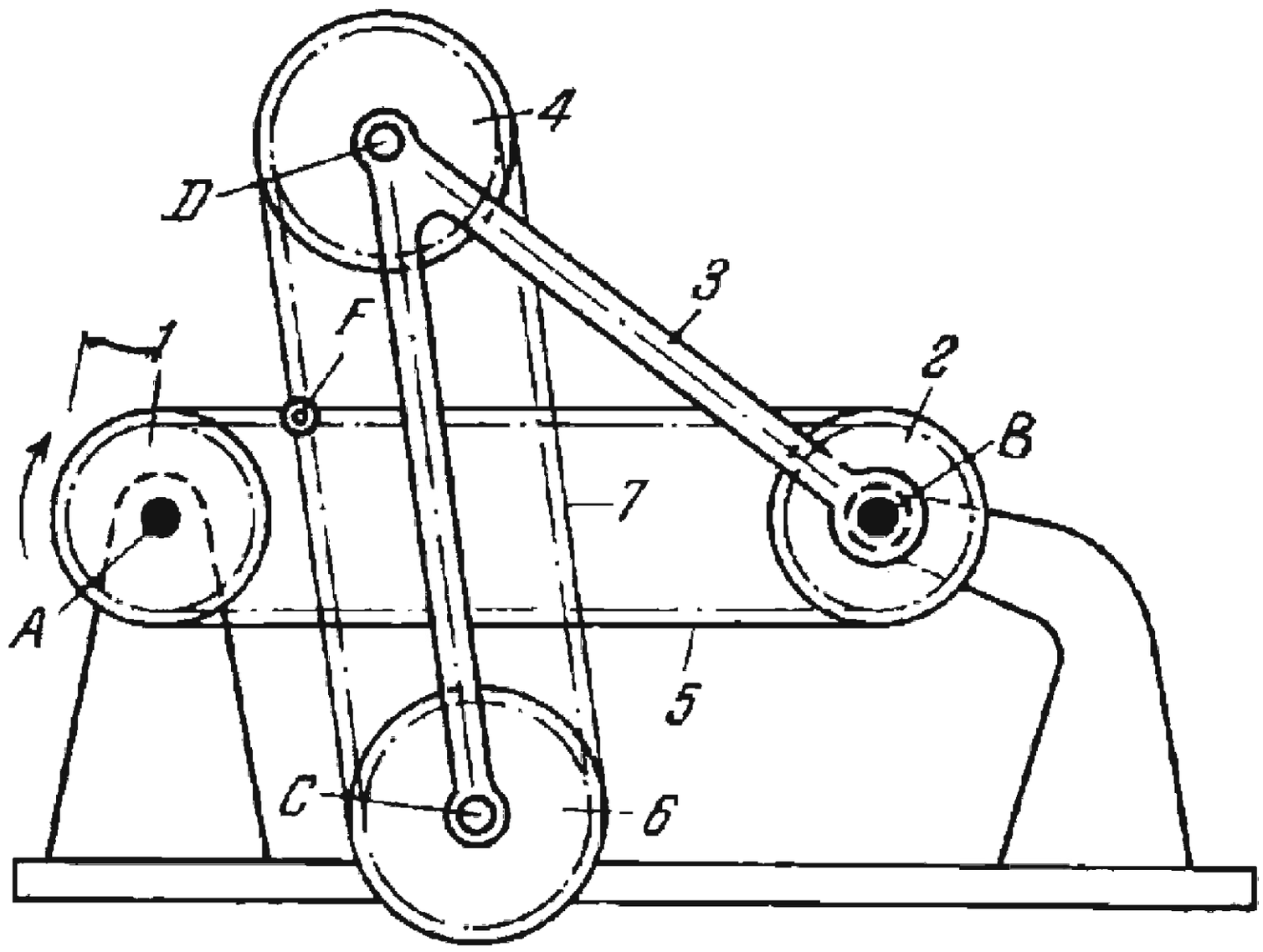
Link *1* rotates about fixed axis *A* and is connected by turning pair *B* to pulley *6*. Flexible link *8* runs over pulleys *4* and *6*. Pulley *4* is rigidly attached to the base. Flexible link *7* runs over pulleys *2* and *5* which rotate about axes *B* and *A*. Link *3* is connected by turning pairs *C* and *D* to flexible links *7* and *8*. When link *1* rotates about axis *A*, pulleys *2* and *5* rotate about axes *B* and *A*, imparting a complex motion to link *3*.

HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS



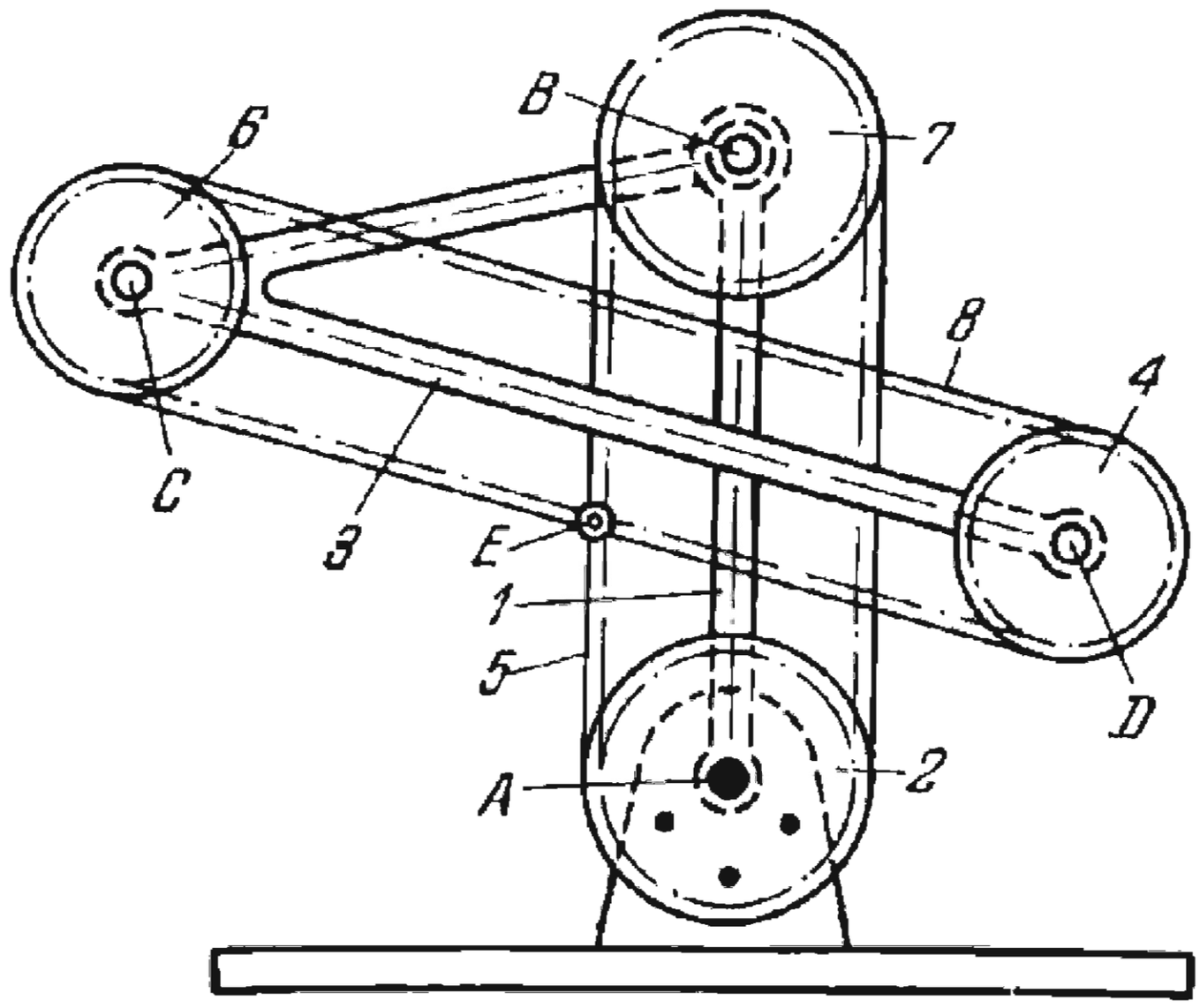
Pulleys *2* and *5* are of equal diameter, as are pulleys *4* and *6*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *C* to pulleys *4*, *5* and *6*. Flexible link *8* runs over pulleys *2* and *5*. Pulley *2* is rigidly attached to the base. Flexible link *7* runs over pulleys *4* and *6*. Link *3* is connected by turning pairs *D* and *E* to flexible links *8* and *7*. When link *1* turns about axis *A*, pulleys *4* and *6* rotate about axes *B* and *C*, imparting a complex motion to link *3*.

2102	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



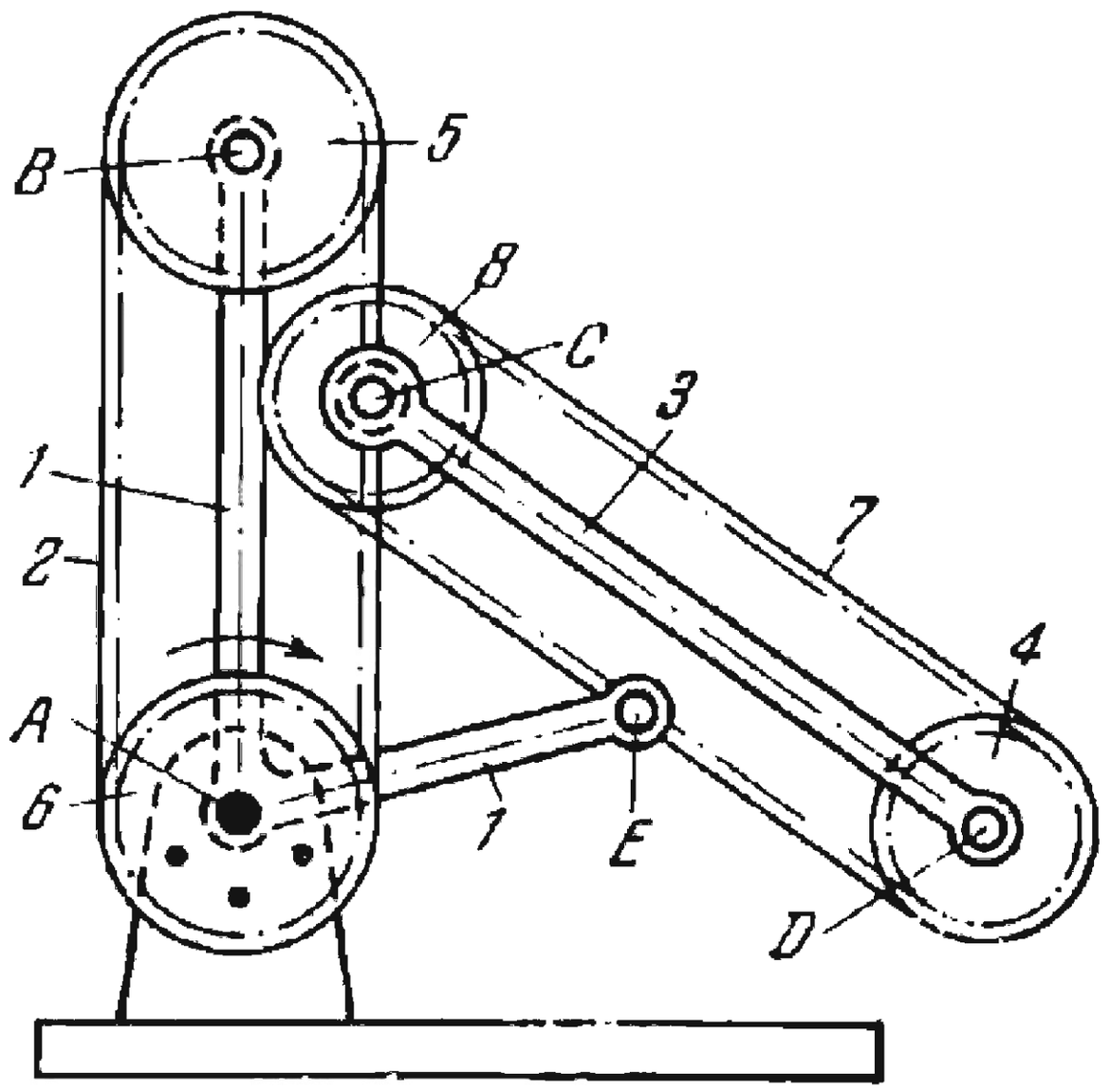
Pulleys *1* and *2* are of equal diameter, as are pulleys *4* and *6*. Pulley *1* rotates about fixed axis *A* and, through flexible link *5*, rotates pulley *2* about fixed axis *B*. Link *3*, designed as a bent lever, turns about axis *B* and is connected by turning pairs *D* and *C* to pulleys *4* and *6*. Flexible link *7* runs over pulleys *4* and *6* and is connected by turning pair *F* to flexible link *5*. When pulley *1* rotates about axis *A*, pulleys *4* and *6* rotate about axes *D* and *C*, imparting oscillating motion to link *3*.

2103	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



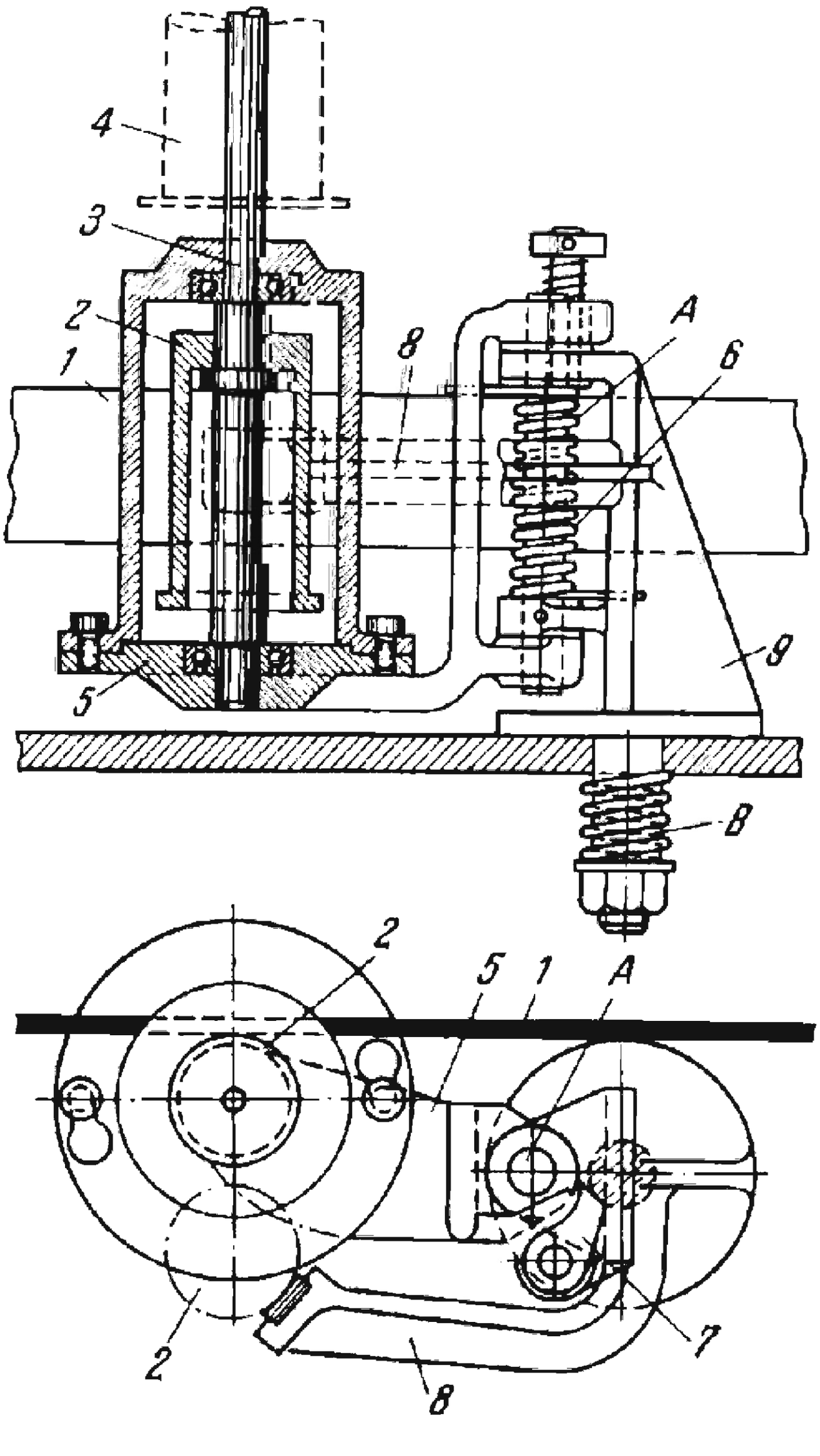
Pulleys *2* and *7* are of equal diameter, as are pulleys *4* and *6*. Link *1* turns about fixed axis *A* and is connected by turning pair *B* to pulley *7*. Flexible link *5* runs over pulleys *2* and *7*. Pulley *2* is rigidly attached to the base. Link *3*, designed as a bent lever, is connected by turning pairs *B*, *C* and *D* to link *1* and to pulleys *6* and *4*. Flexible link *8* runs over pulleys *4* and *6* and is connected by turning pair *E* to flexible link *5*. When link *1* turns about axis *A*, pulleys *4* and *6* rotates about axes *D* and *C*, imparting a complex motion to link *3*.

2104	HAIN LINKWORK SATELLITE MECHANISM WITH TWO FLEXIBLE LINKS	FL Sa



Pulleys *5* and *6* are of equal diameter, as are pulleys *4* and *8*. Link *1*, designed as a bent lever, turns about fixed axis *A* and is connected by turning pairs *B* and *E* to pulley *5* and to flexible link *7*. Flexible link *2* runs over pulleys *5* and *6* and is connected by turning pair *C* to link *3*. Pulley *6* is rigidly attached to the base. Link *3* is connected by turning pairs *D* and *C* to pulleys *4* and *8*. Flexible link *7* runs over pulleys *4* and *8*. When link *1* turns about axis *A*, links *4* and *8* rotate about axes *D* and *C*, imparting a complex motion to link *3*.

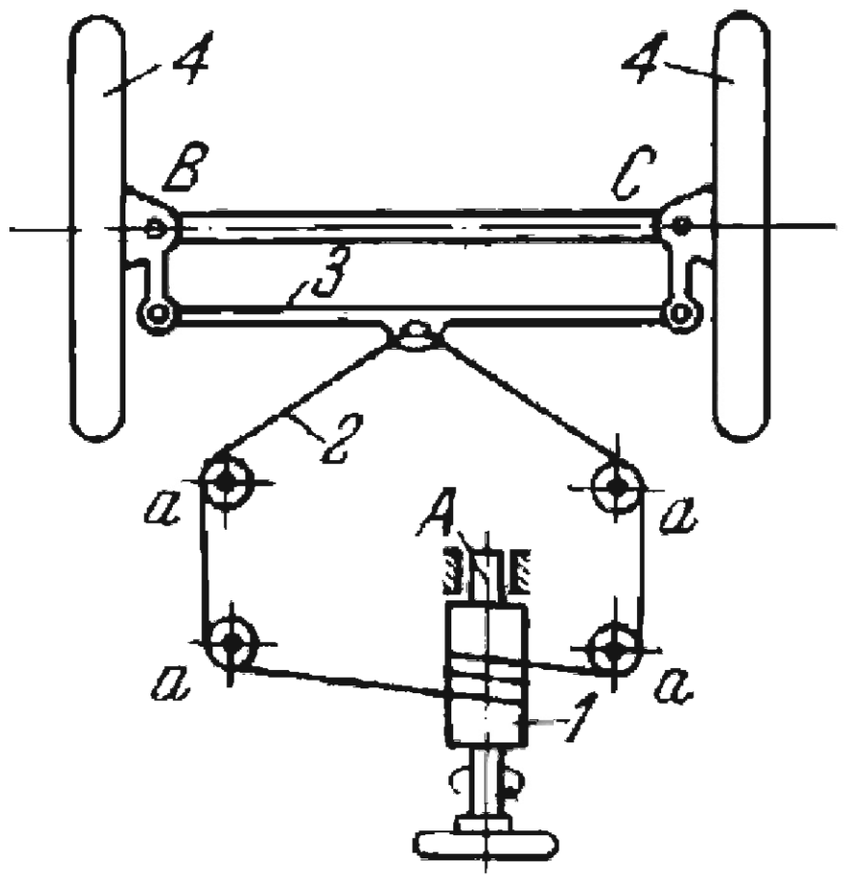
2105	LEVER-TYPE FLEXIBLE-LINK MECHANISM FOR RAPIDLY STOPPING AND RETRACTING THE BOBBIN SPINDLE IN TEXTILE MACHINERY	FL FD



When roller *2* contacts moving belt *1* rotation is transmitted to spindle *3* on which bobbin *4* is mounted. The thread is wound on rotating bobbin *4*. When the bobbin is full, overhanging plate *5* swings with respect to axis *A*, overcoming the resistance of torsion spring *6*, until pawl *7* engages overhanging plate *5*. At this, roller *2* contacts braking lever *8* and is stopped, enabling filled bobbin *4* to be readily removed from the spindle. By turning bracket *9* with respect to axis *B*, pawl *7* is disengaged from plate *5*. Plate *5* is returned by spring *6* to its initial position and rotation is transmitted again to spindle *3* on which an empty bobbin has been mounted.

2106 LINKWORK WHEEL-STEERING MECHANISM WITH A FLEXIBLE LINK

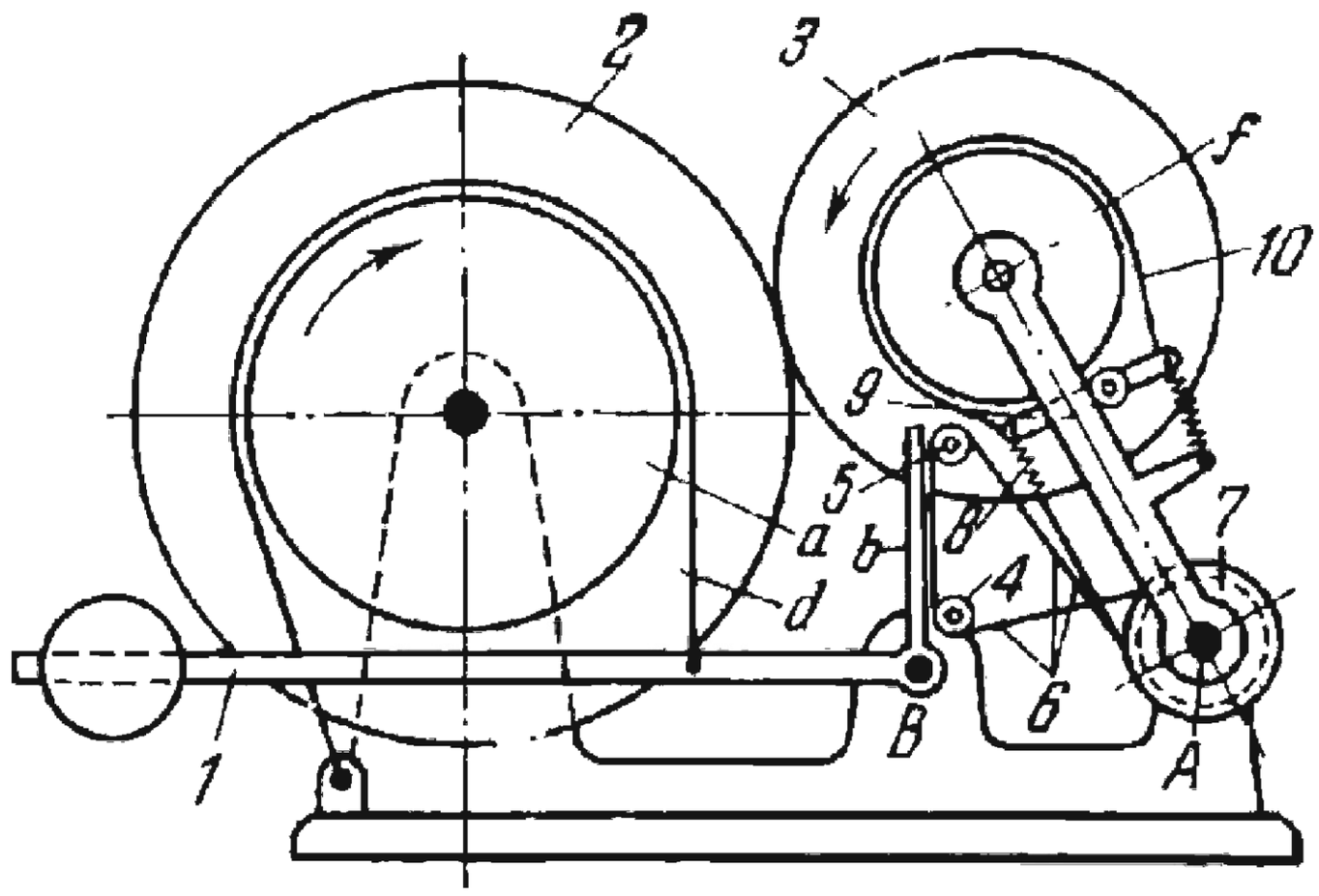
FL
FD



Flexible link *2* is wound several turns around drum *1* and its ends are attached to cross steering rod (tie-rod) *3*. When drum *1* is turned about fixed axis *A*, one branch of flexible link *2* is wound on the drum and the other branch is unwound. This turns wheels *4* about axes *B* and *C*.

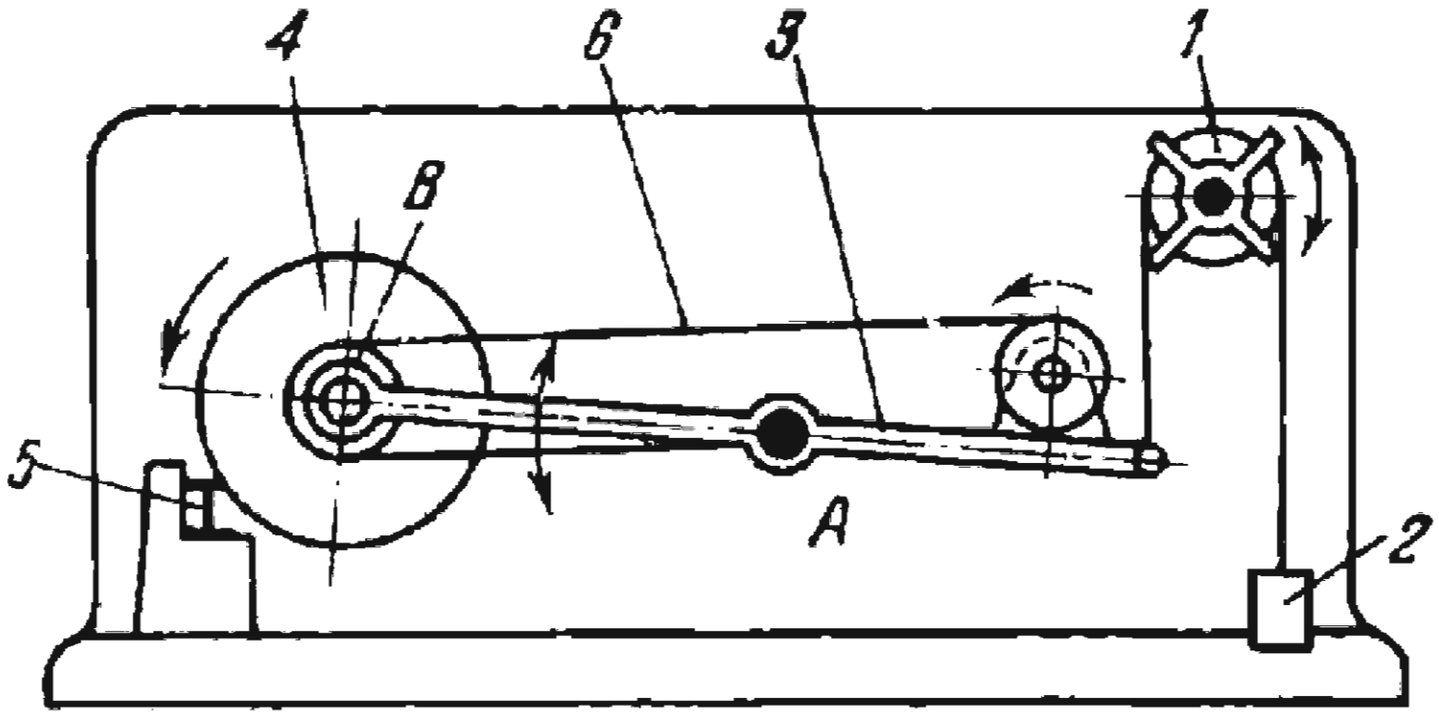
2107 BYKOV LEVER-TYPE FLEXIBLE-LINK BRAKING DEVICE FOR A WARPING FRAME

FL
FD



When lever *1* is turned counterclockwise about fixed axis *B*, both drum *2* and pulley *3* are braked. Drum *2*, rigidly attached to brake drum *a*, is braked by the tensioning of steel band *d*. When lever *1* is turned, its end *b* with small pulleys *4* and *5* is inclined. At this, flexible link *6*, running over pulleys *4* and *5* and pulley *7*, mounted freely on fixed axis *A*, tensions spring *8*. This turns lever *9* and thereby tensions steel band *10*, braking drum *f* of pulley *3*.

2108	LEVER-TYPE FLEXIBLE-LINK MECHANISM OF A PENDULUM CROSS-CUT SAW	FL FD



When pulley *1* turns clockwise, counterbalancing load *2* is lowered. This raises the right-hand end of lever *3* which turns about fixed axis *A*. The left-hand end with saw blade *4* is lowered to cut timber *5*. Saw blade *4* is rotated about axis *B* through belt drive *6* which is powered by an electric motor mounted on the right-hand end of lever *3*. When pulley *1* is turned counterclockwise, the saw blade is raised.

SECTION TEN

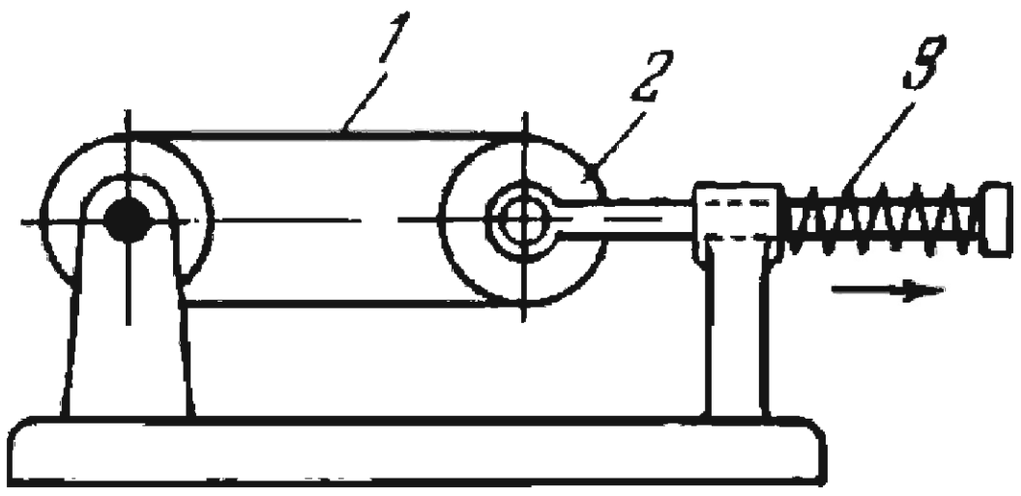
Elastic-Link Lever Mechanisms

EL

1. General-Purpose Four-Link Mechanisms 4L (2109 through 2113)
2. General-Purpose Five-Link Mechanisms 5L (2114 through 2117)
3. General-Purpose Six-Link Mechanisms 6L (2118, 2119 and 2120)
4. Hammer, Press and Die Mechanisms HP (2121 through 2124)
5. Operating Claw Mechanisms of Motion Picture Cameras OC (2125, 2126 and 2127)
6. Clutch and Coupling Mechanisms C (2128 and 2129)
7. Switching, Engaging and Disengaging Mechanisms SE (2130 through 2136)
8. Mechanisms of Measuring and Testing Devices M (2137 through 2140)
9. Mechanisms for Mathematical Operations MO (2141)
10. Governor Mechanisms G (2142)
11. Mechanisms of Vibrating Machines and Devices VM (2143 through 2158)

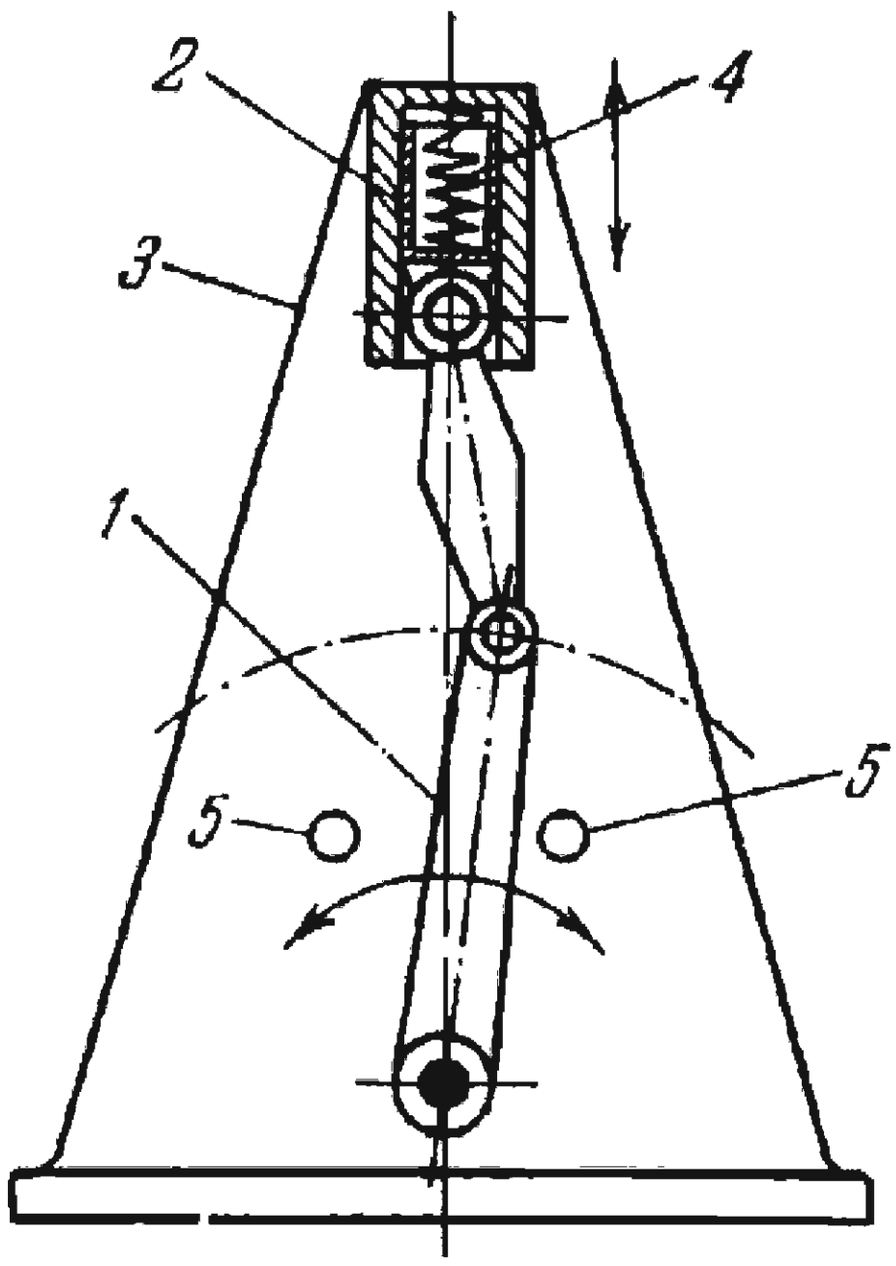
1. GENERAL-PURPOSE FOUR-LINK MECHANISMS (2109 through 2113)

2109	SPRING-OPERATED TENSION PULLEY	EL 4L



Flexible link *1* is tensioned by pulley *2* which is subject to the action of spring *3*.

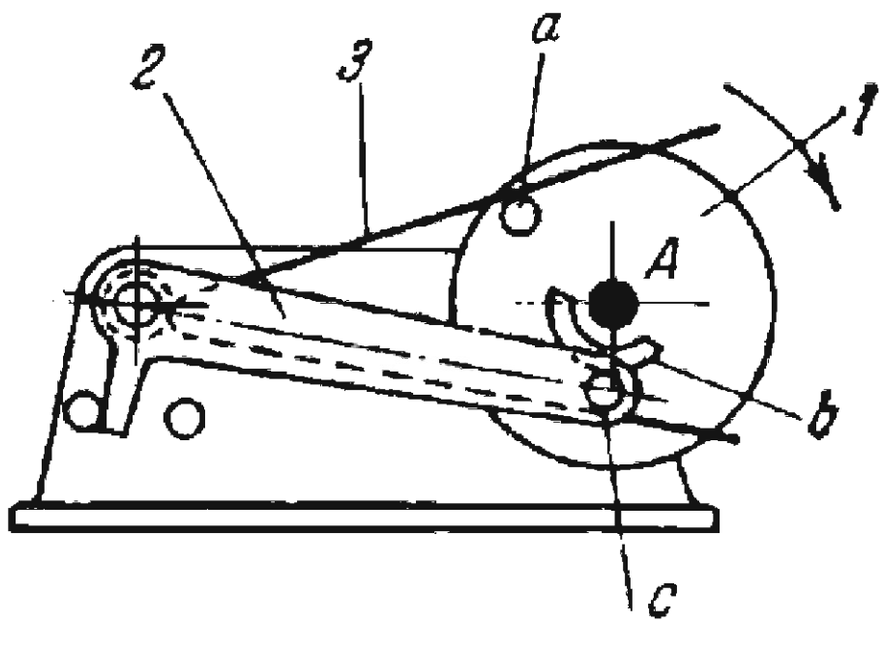
2110	SLIDER-CRANK MECHANISM WITH AN ELASTIC LINK	EL 4L



Slider *2* is designed as a hollow cylinder which contains helical spring *4*. When link *1* is oscillated, slider *2* reciprocates in guides of upright *3*, compressing and releasing spring *4*. The extreme positions of link *1* are located by pins *5*.

2111 ELASTIC-LINK LEVER MECHANISM

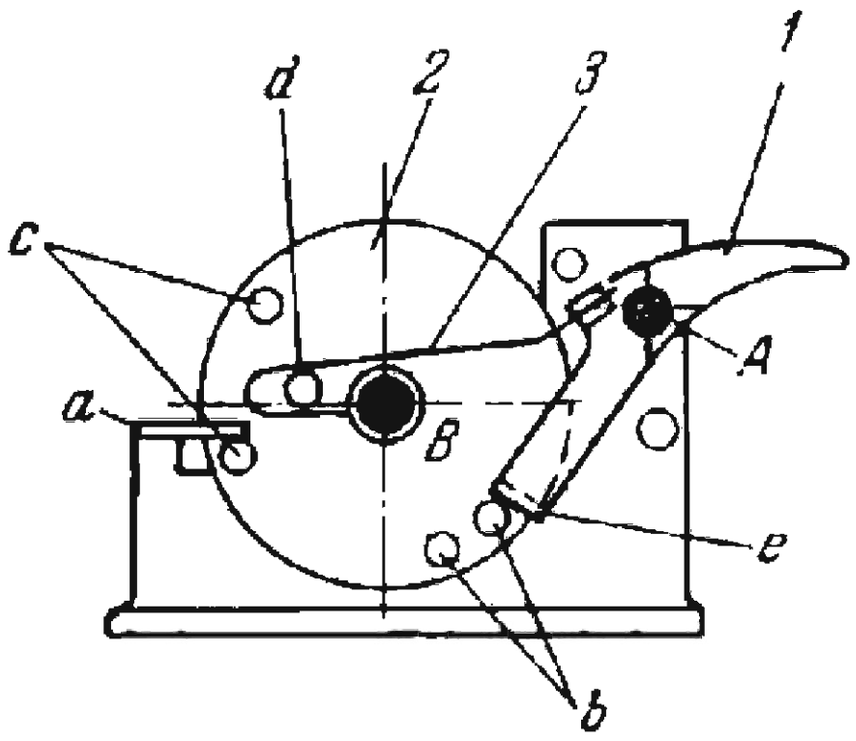
EL 4L



Disk *1* rotates about fixed axis *A* and has pin *a* and circular lug *b*. Lever *2* has pin *c* and is in its extreme position (as shown) as long as lug *b* slides along pin *c*. At this time, pin *a* bends flat spring *3*. When pin *c* drops off the end of lug *b*, spring *3* turns lever *2* to its other extreme position. After this, pin *a* engages the lower branch of spring *3* and returns lever *2* to its initial position.

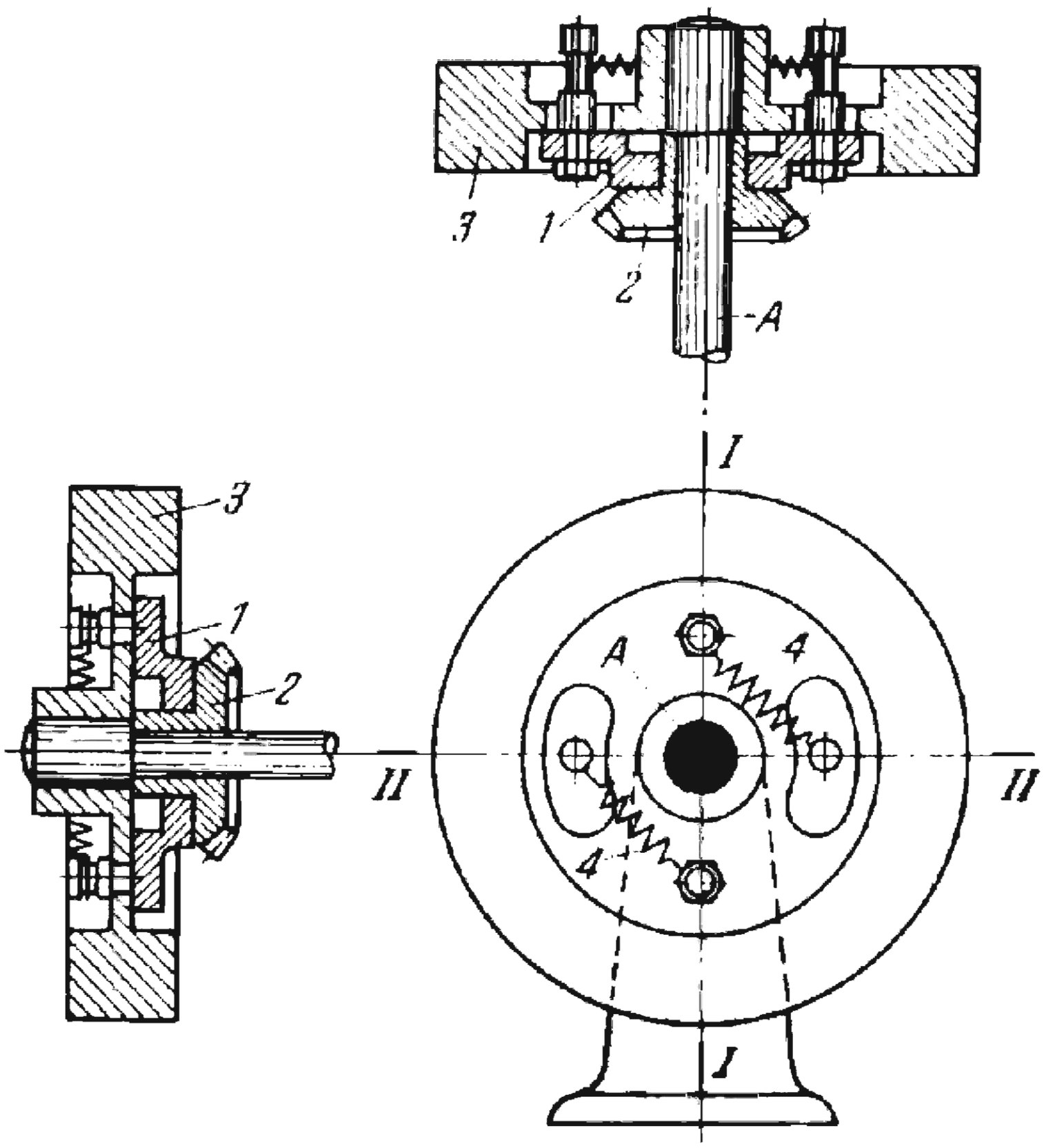
2112 ELASTIC-LINK LINK-GEAR MECHANISM

EL 4L



Lever *1* turns about fixed axis *A* and has spring *3* which is bent in the shape of a slotted link sliding along pin *d* of disk *2*. Disk *2* turns about fixed axis *B* and has pins *b* and *c*. In the position shown, one of pins *c* is against stop *a* and one of pins *b* against end *e* of lever *1*. When lever *1* is turned counterclockwise, spring *3* presses against pin *d* and turns disk *2* since end *e* of lever *1* turns away and releases pin *b*. Disk *2* turns through an angle determined by the distance between pins *c*. After this, lever *1* can be turned back to its initial position.

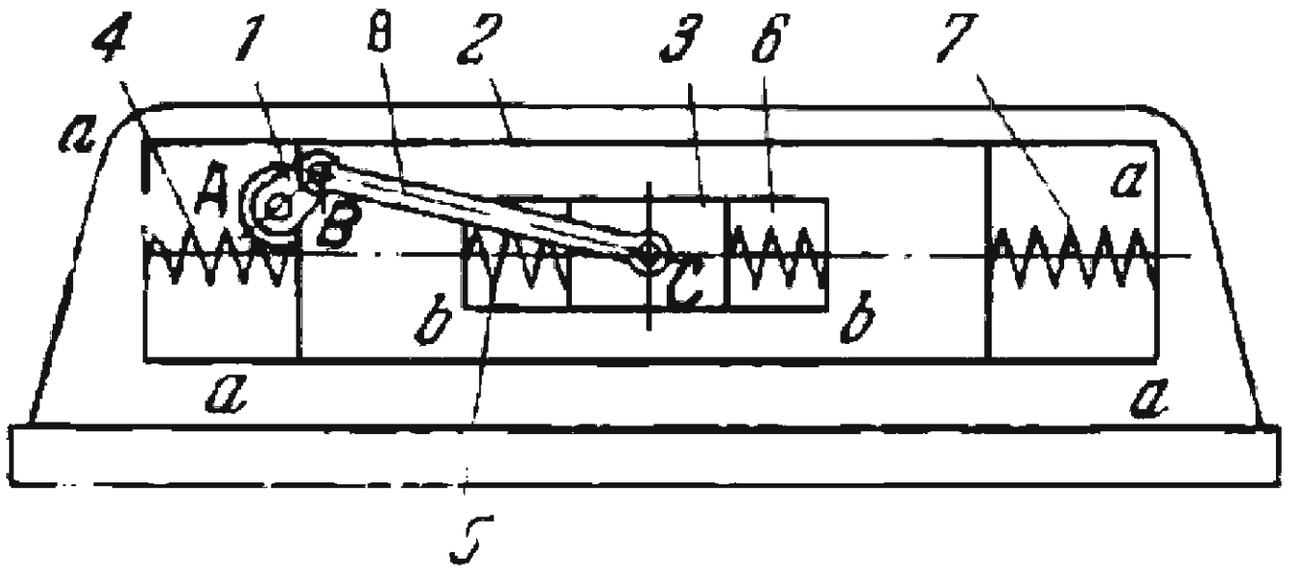
2113	ELASTIC-LINK LEVER-TYPE MECHANISM FOR CONVERTING INTERMITTENT INTO CONTINUOUS ROTATION	EL 4L



Disk *1*, rigidly attached to bevel gear *2*, rotates freely on shaft *A* and is connected by springs *4* to heavy flywheel *3* which is keyed on shaft *A*. A pulsed drive from gear *2* produces intermittent rotation of disk *1*. This intermittent rotation is converted into continuous rotation of flywheel *3*.

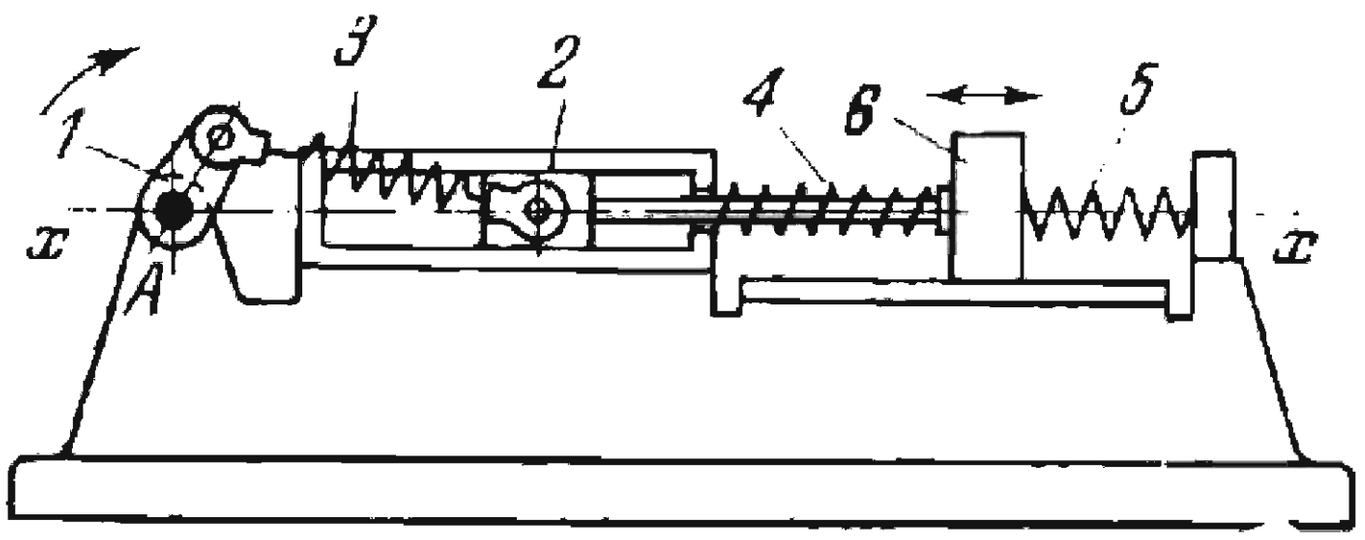
2. GENERAL-PURPOSE FIVE-LINK MECHANISMS (2114 through 2117)

2114	ELASTIC-LINK SLIDER-CRANK MECHANISM WITH TWO SLIDERS	EL 5L



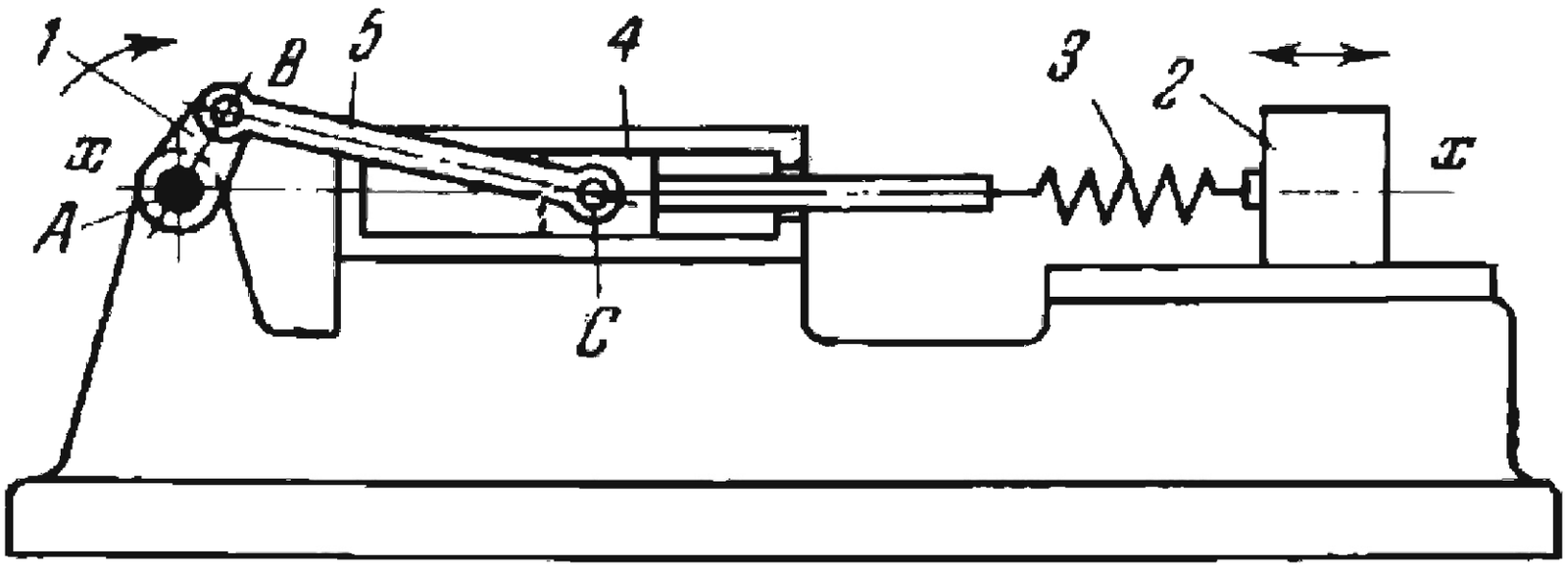
Crank *1* rotates about axis *A* of slider *2* which moves in fixed guides *a-a*. Connecting rod *8* is connected by turning pairs *B* and *C* to crank *1* and to slider *3* which moves in guides *b-b* of slider *2*. Sliders *2* and *3* are spring-loaded by springs *4*, *5*, *6* and *7*. When crank *1* rotates, sliders *2* and *3* have a vibrating motion.

2115	SLIDER-CRANK MECHANISM WITH AN ELASTIC CONNECTING ROD	EL 5L



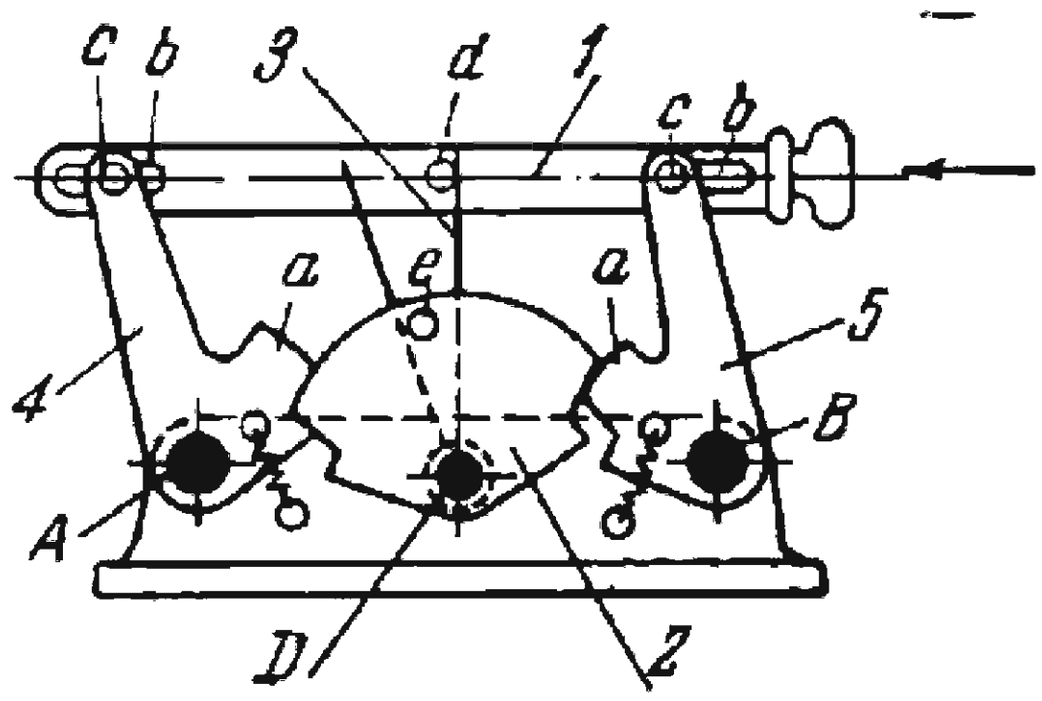
Crank *1* rotates about fixed axis *A*. Slider *2* moves along a fixed guide and is connected to crank *1* by spring *3*. Slider *6* is spring-loaded by springs *4* and *5*. When crank *1* rotates, slider *6* has a vibrating motion along axis *x-x* due to the action of springs *3*, *4* and *5*.

2116	ELASTIC-LINK SLIDER-CRANK MECHANISM WITH TWO SLIDERS	EL 5L



Crank *1* rotates about fixed axis *A*. Connecting rod *5* is connected by turning pairs *B* and *C* to crank *1* and to slider *4* which moves in fixed guides. Slider *4* is connected by spring *3* to slider *2* which moves along a fixed guide.

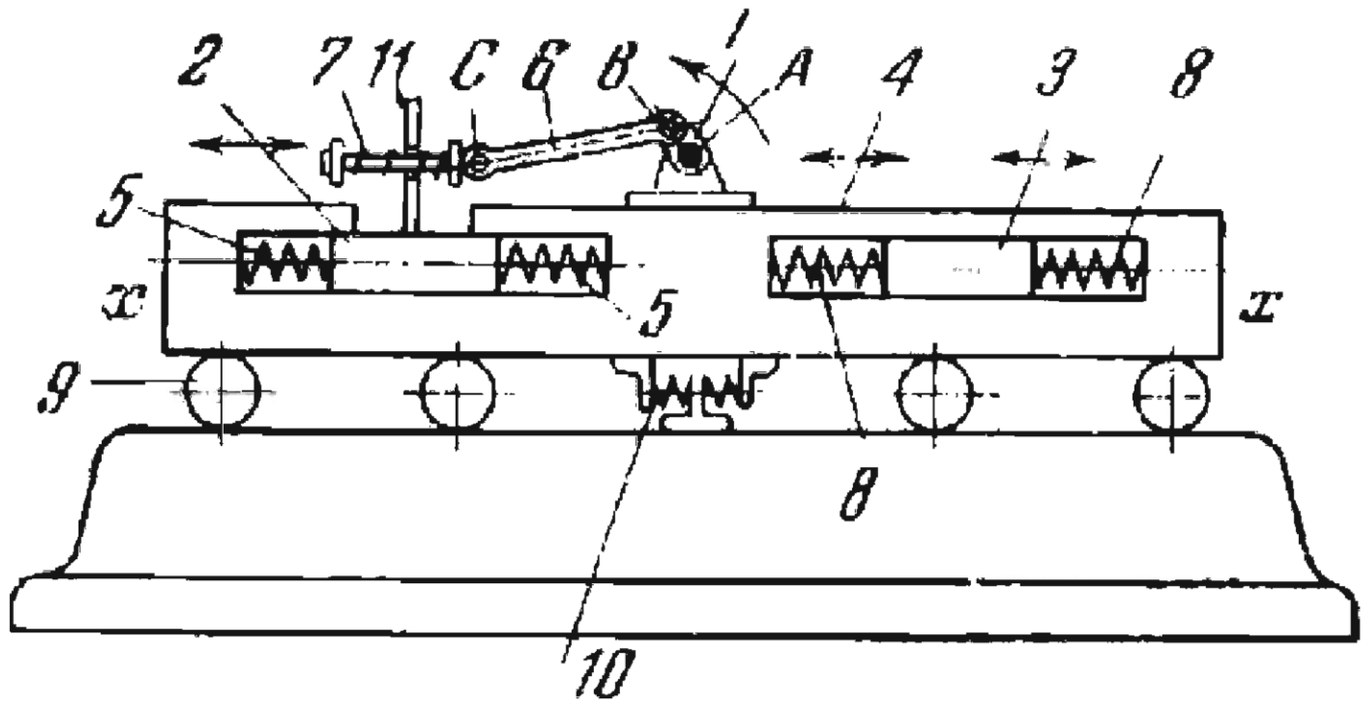
2117	LINKWORK MECHANISM WITH AN ELASTIC LINK	EL 5L



Levers *4* and *5* turn about fixed axes *A* and *B* and have pins *c* that enter slots *b* of link *1*. Link *2* turns about fixed axis *D* and has flat spring *3*. One end of spring *3* engages pin *d* of link *1* and the other end engages pin *e* of link *2*. When link *1* reciprocates, link *2* oscillates about axis *D* due to the action of spring *3*. Projections *a* of levers *4* and *5* engage grooves in link *2*, thereby indexing the link in its extreme positions.

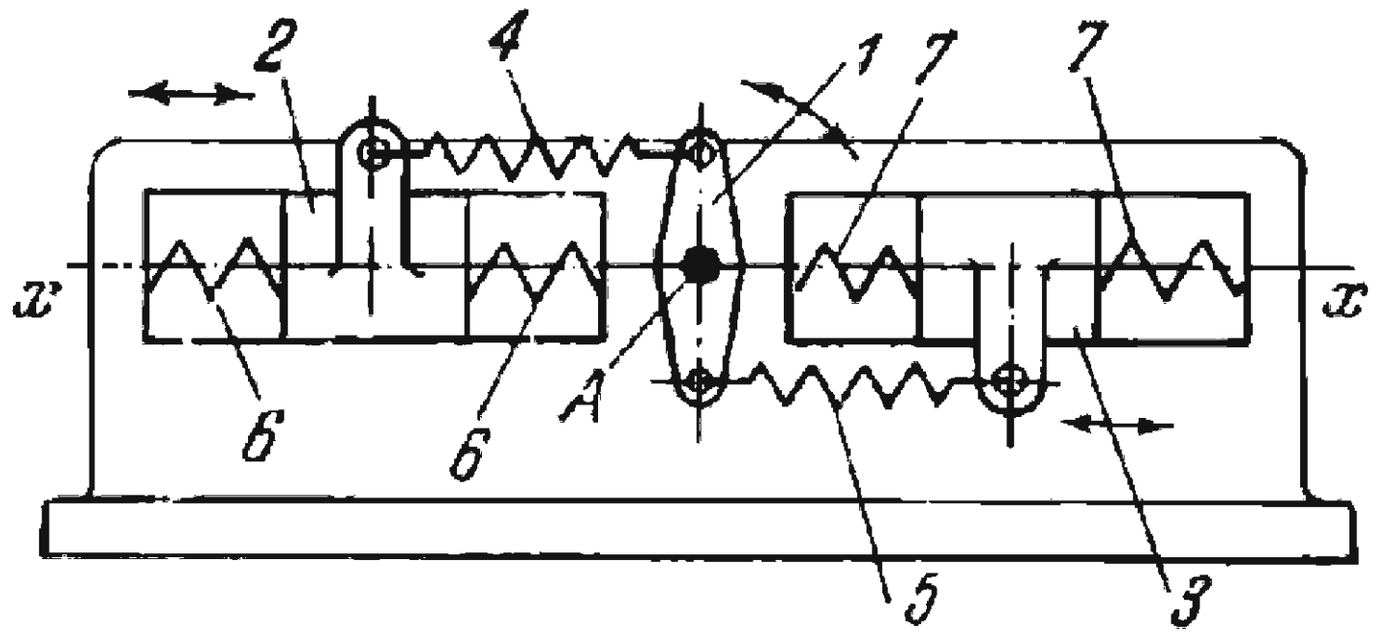
3. GENERAL-PURPOSE SIX-LINK MECHANISMS (2118, 2119 and 2120)

2118	ELASTIC-LINK SLIDER-CRANK MECHANISM	EL 6L



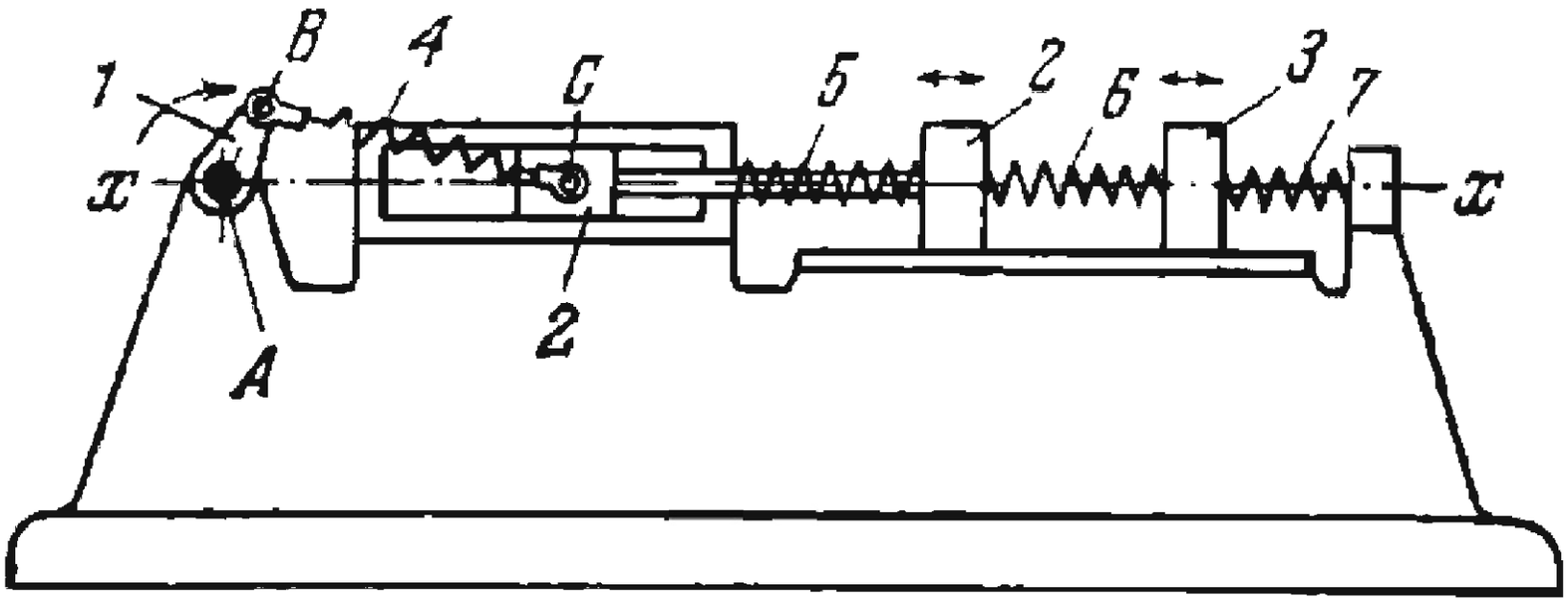
Crank *1* rotates about axis *A*. Connecting rod *6* is connected by turning pairs *B* and *C* to crank *1* and to slider *11* which moves along guides of link *2*. Link *2* is connected to movable frame *4* by springs *5* and to connecting rod *6* by spring *7*. Link *3* is connected to movable frame *4* by springs *8*. Movable frame *4* rests on rollers *9* and is connected to the base by springs *10*. When crank *1* rotates, links *2* and *4* have vibrating motions along axis *x*-*x*. Slider *3* is vibrated by inertia forces in the slot in frame *4*.

2119	SLIDER-CRANK MECHANISM WITH ELASTIC CONNECTING RODS AND TWO SLIDERS	EL 6L



Link *1* oscillates about fixed axis *A* and is connected by springs *4* and *5* to sliders *2* and *3* which move along fixed guides. Sliders *2* and *3* are spring-loaded by springs *6* and *7*. When link *1* oscillates about axis *A*, links *2* and *3* have vibrating motions along axis *x-x* due to the action of springs *4*, *5*, *6* and *7*.

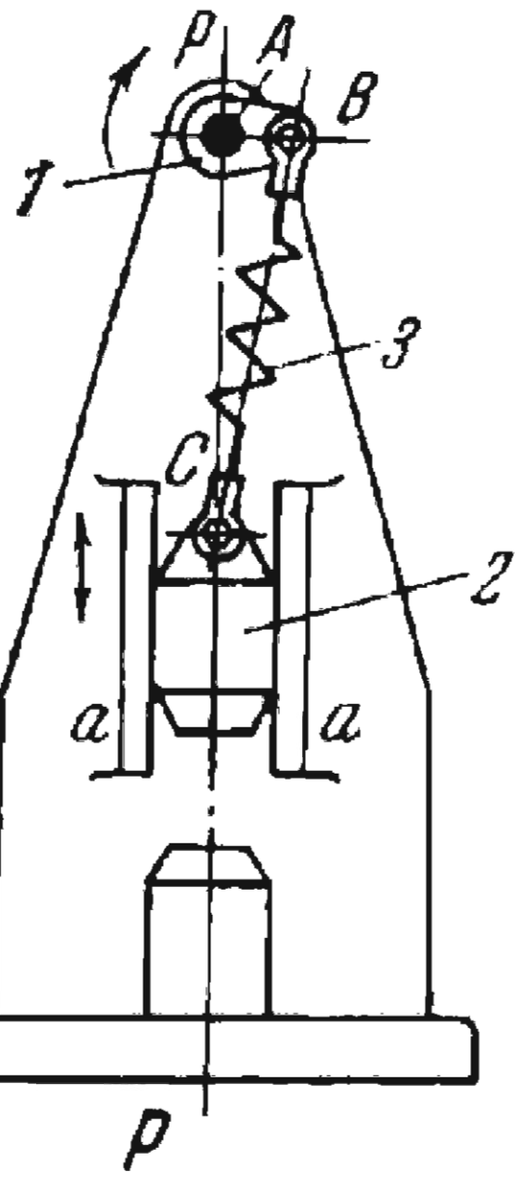
2120	SLIDER-CRANK MECHANISM WITH AN ELASTIC CONNECTING ROD AND TWO SLIDERS	El. 6L



Crank *1* rotates about fixed axis *A*. Slider *2* moves in fixed guides and is connected by spring *4* to crank *1*. Slider *3* moves along a fixed guide and is connected by spring *6* to slider *2*. Sliders *2* and *3* are spring-loaded by springs *5* and *7*. When crank *1* rotates, sliders *2* and *3* have vibrating motions along axis *x-x* due to the action of springs *4*, *5*, *6* and *7*.

2121 ELASTIC-LINK SLIDER-CRANK MECHANISM OF A POWER HAMMER

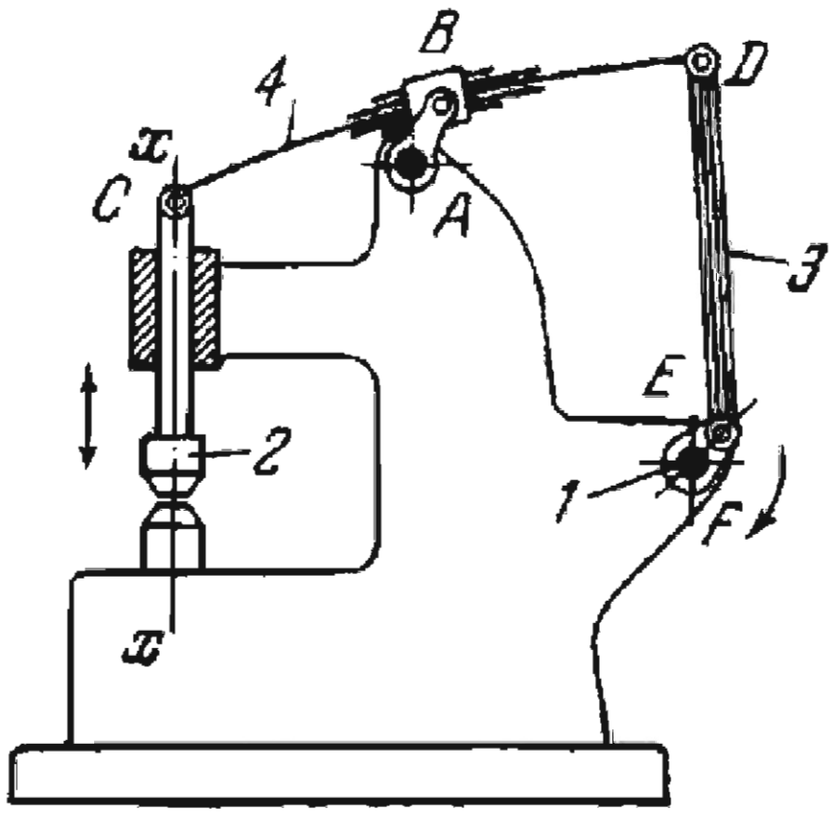
EL
HP



Crank *1* rotates about fixed axis *A*. Slider (ram) *2* moves in fixed guides *a-a*. Spring *3* connects points *B* and *C* of crank *1* and ram *2*. When crank *1* rotates, ram *2* has a reciprocating motion along axis *p-p* due to the action of spring *3*.

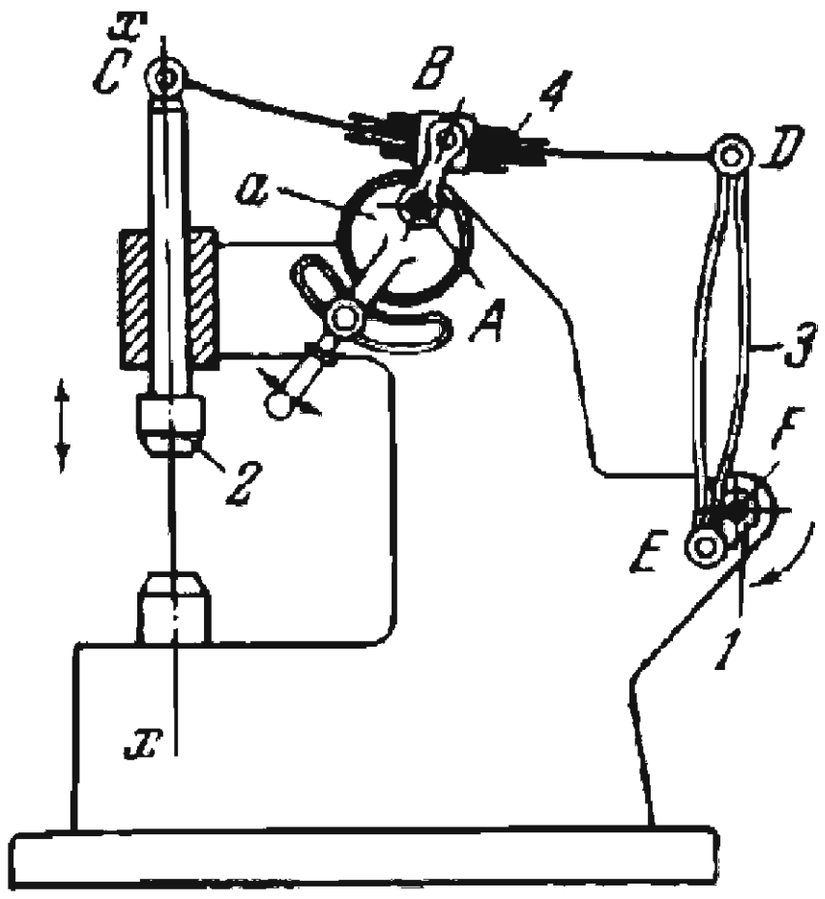
2122 ELASTIC-LINK SLIDER-CRANK MECHANISM OF A POWER HAMMER

EL
HP



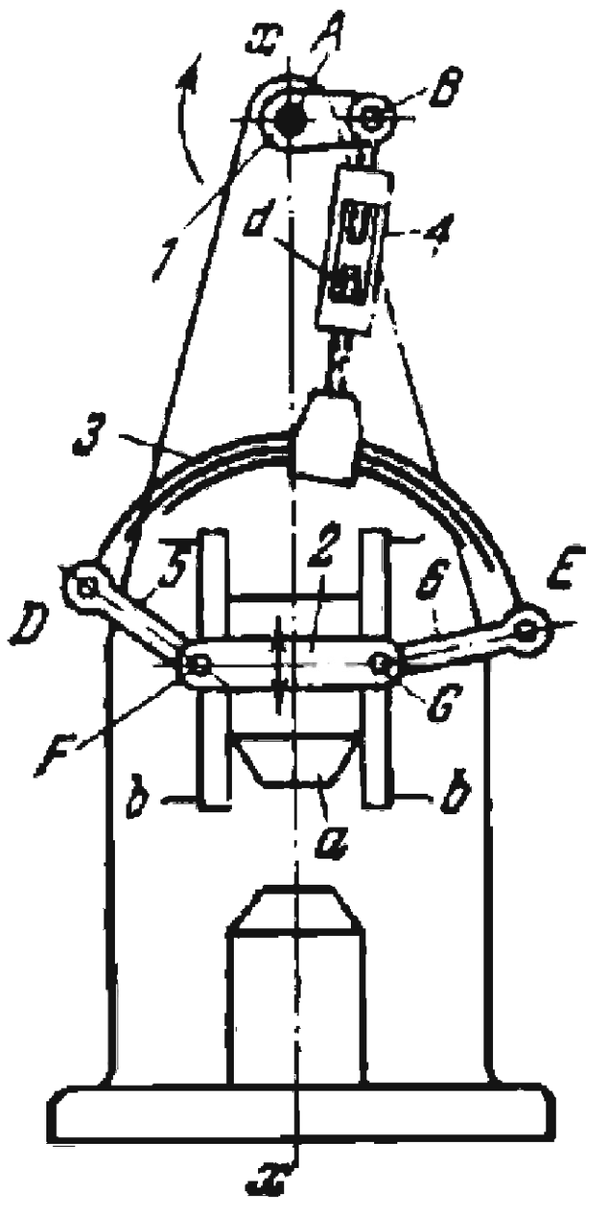
Connecting rod *4* of slider-crank linkage *ABC* is designed as a leaf spring which is connected by turning pair *D* to link *3*, also designed as a leaf spring. Link *3* is connected by turning pair *E* to crank *1* which rotates about fixed axis *F*. When crank *1* rotates, ram *2* reciprocates along axis *x-x* due to the action of leaf springs *3* and *4*.

2123	ELASTIC-LINK SLIDER-CRANK MECHANISM OF A POWER HAMMER	EL HP



Connecting rod *4* of slider-crank linkage *ABC* is designed as a leaf spring which is connected by turning pair *D* to link *3*, also designed as a leaf spring. Link *3* is connected by turning pair *E* to crank *1* which rotates about fixed axis *F*. When crank *1* rotates, ram *2* reciprocates along axis *x-x* due to the action of leaf springs *3* and *4*. The stroke of ram *2* can be varied by changing the position of pivot *A*. This is done by turning eccentric *a* and then clamping it.

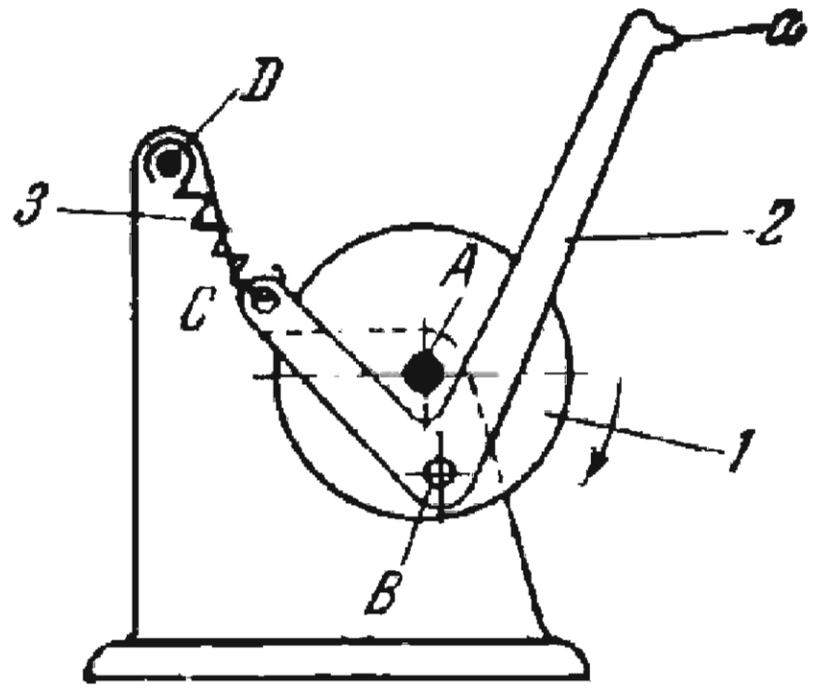
2124	ELASTIC-LINK SLIDER-CRANK MECHANISM OF A POWER HAMMER	EL HP



Ram *a* slides in fixed guides *b-b*. Rigidly attached to the ram is cross-piece *2* which is connected by turning pairs *F* and *G* to links *5* and *6*. Leaf spring *3* is connected by turning pairs *D* and *E* to links *5* and *6* and is rigidly attached to connecting rod *4*. Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *4*. When crank *1* rotates, ram *2* reciprocates along axis *x-x* due to the action of leaf spring *3*. Connecting rod *4* has a screw-type adjustment that can change the position and length of the ram stroke.

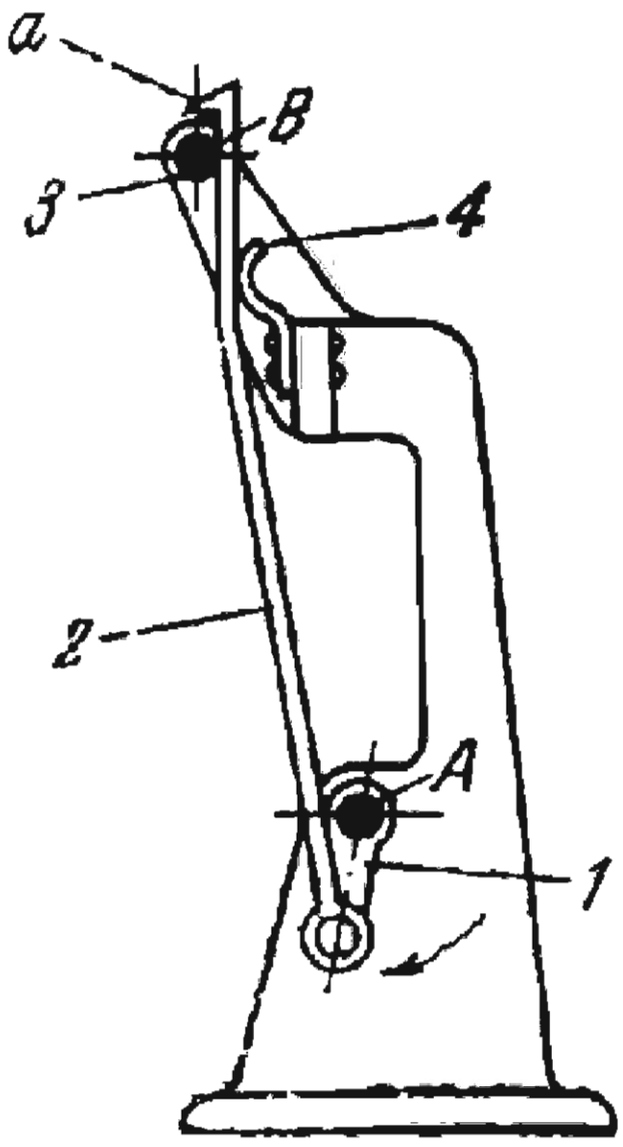
5. OPERATING CLAW MECHANISMS OF MOTION PICTURE CAMERAS (2125, 2126 and 2127)

2125	LINKWORK OPERATING CLAW MECHANISM WITH AN ELASTIC LINK	EL OC



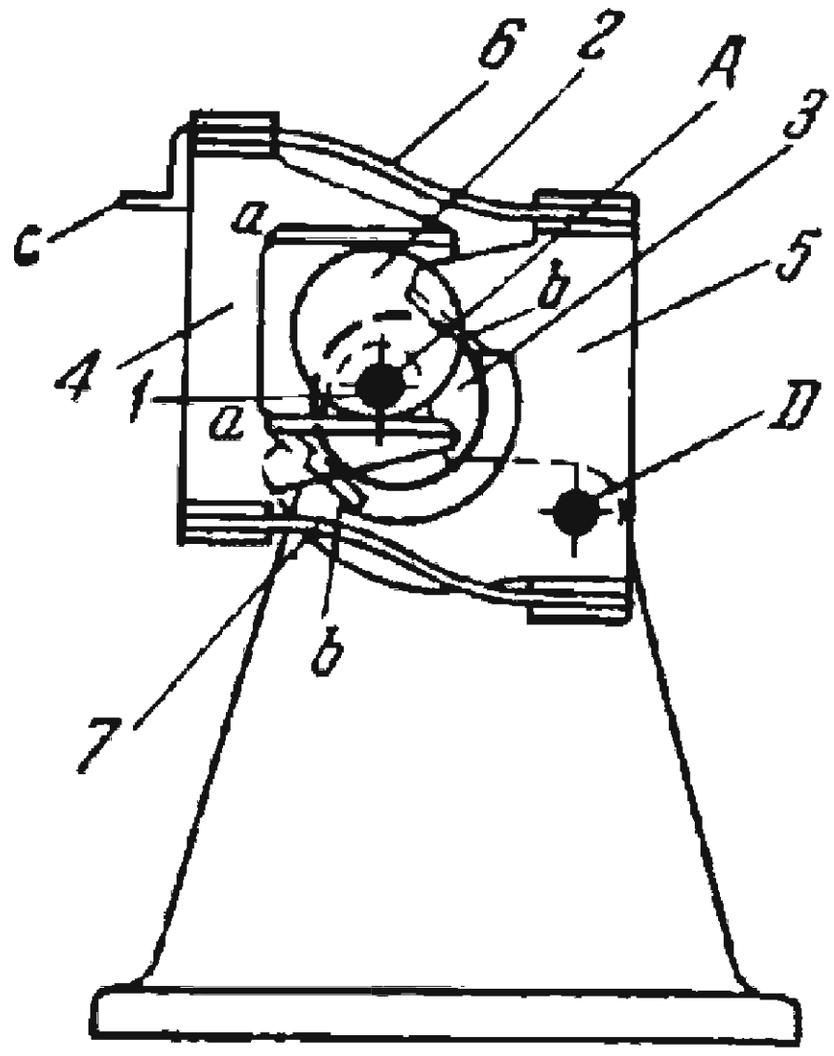
Link *1* rotates about fixed axis *A* and is connected by turning pair *B* to connecting rod *2*, designed as a bent lever. Spring *3* is connected by turning pairs *C* and *D* to connecting rod *2* and to the base. When crank *1* rotates, the tip of claw *a* of connecting rod *2* describes a connecting-rod curve. At one portion of this curve, claw *a* is inserted into a perforation of the film, advances the film and is withdrawn The required shape of the path of claw *a* is obtained by properly selecting the dimensions of spring *3*.

2126	LEVER-TYPE OPERATING CLAW MECHANISM WITH AN ELASTIC LINK	EL OC



When crank *1* rotates about fixed axis *A*, the tip of claw *a* of connecting rod *2* describes a complex connecting-rod curve. At one portion of this curve, claw *a* is inserted into a perforation of the film which it advances. At another portion of the curve, claw *a* is withdrawn from the perforation. The required shape of the path of claw *a* is obtained by properly profiling the part of connecting rod *2* that contacts roller *3* which rotates about fixed axis *B*, and by proper selection of the dimensions of links *1* and *2* and the profile of flat spring *4*.

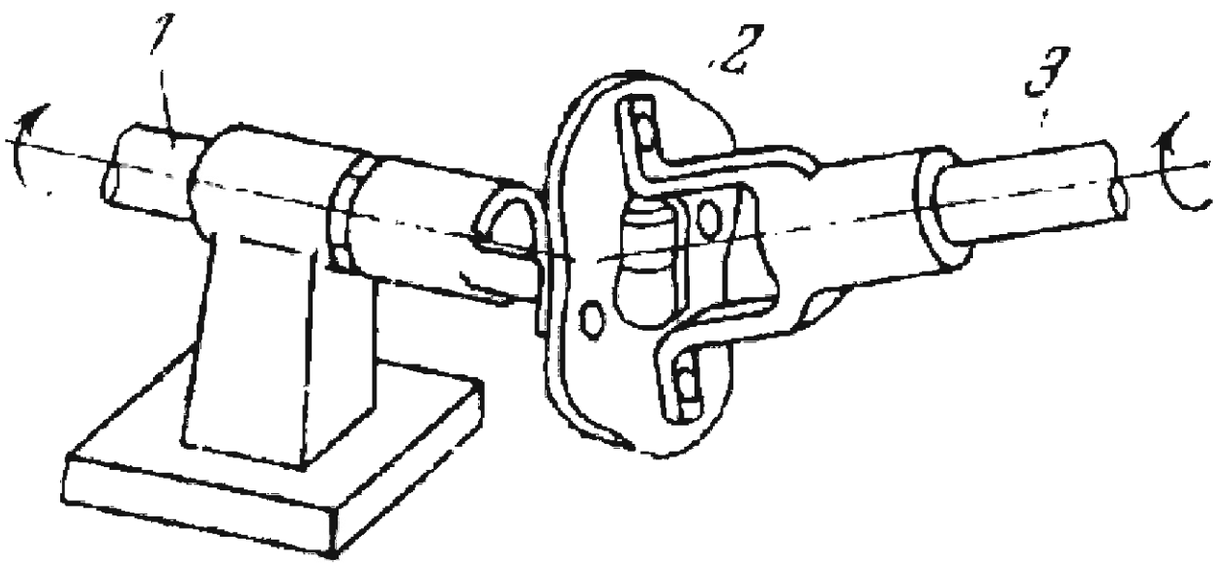
2127	LEVER-CAM OPERATING CLAW MECHANISM WITH ELASTIC LINKS	EL OC



Eccentrics *2* and *3* are keyed on shaft *1* rotating about fixed axis *A*. Eccentric *2* slides in guides *a-a* of link *4*; eccentric *3* slides in guides *b-b* of link *5* which turns about fixed axis *D*. Links *4* and *5* are connected together by flat springs *6* and *7*. Claw *c* is attached to link *4*. When shaft *1* rotates, claw *c* describes a complex curve in which the claw is inserted into a perforation of the film, advances the film and is withdrawn from the perforation.

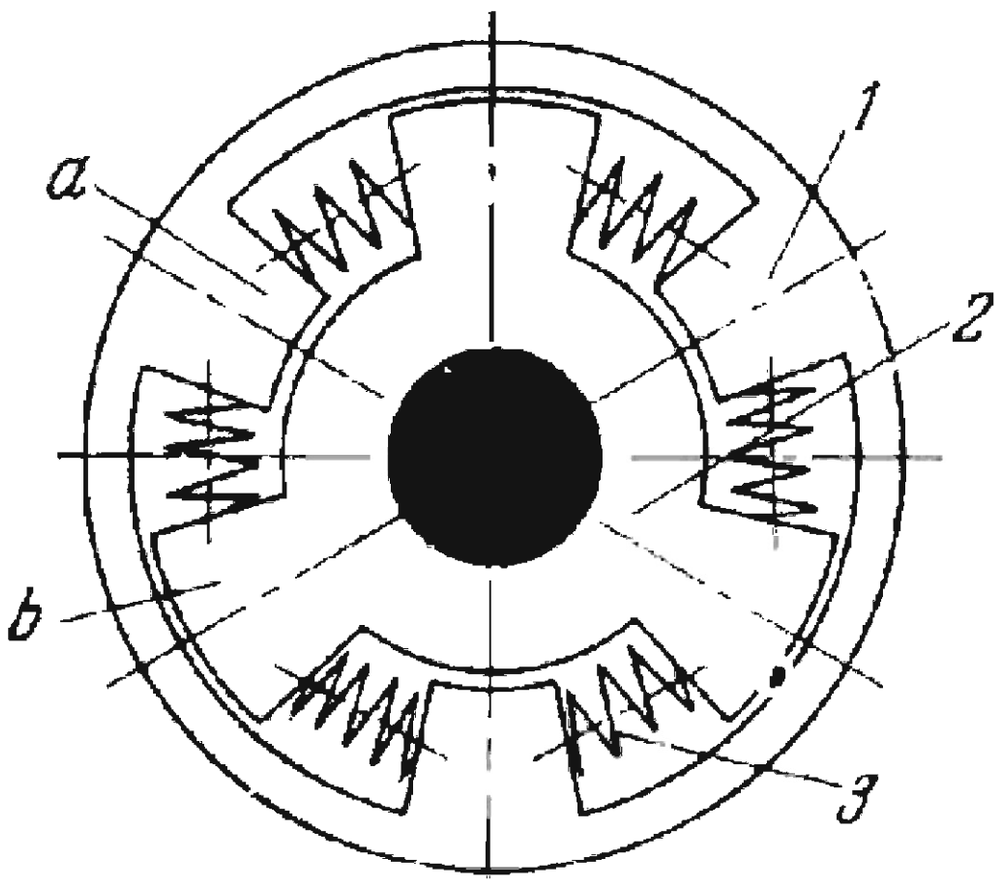
6. CLUTCH AND COUPLING MECHANISMS (2128 and 2129)

2128	LEVER-TYPE SPATIAL MECHANISM WITH A DEFORMABLE LINK (ELASTIC COUPLING)	EL C



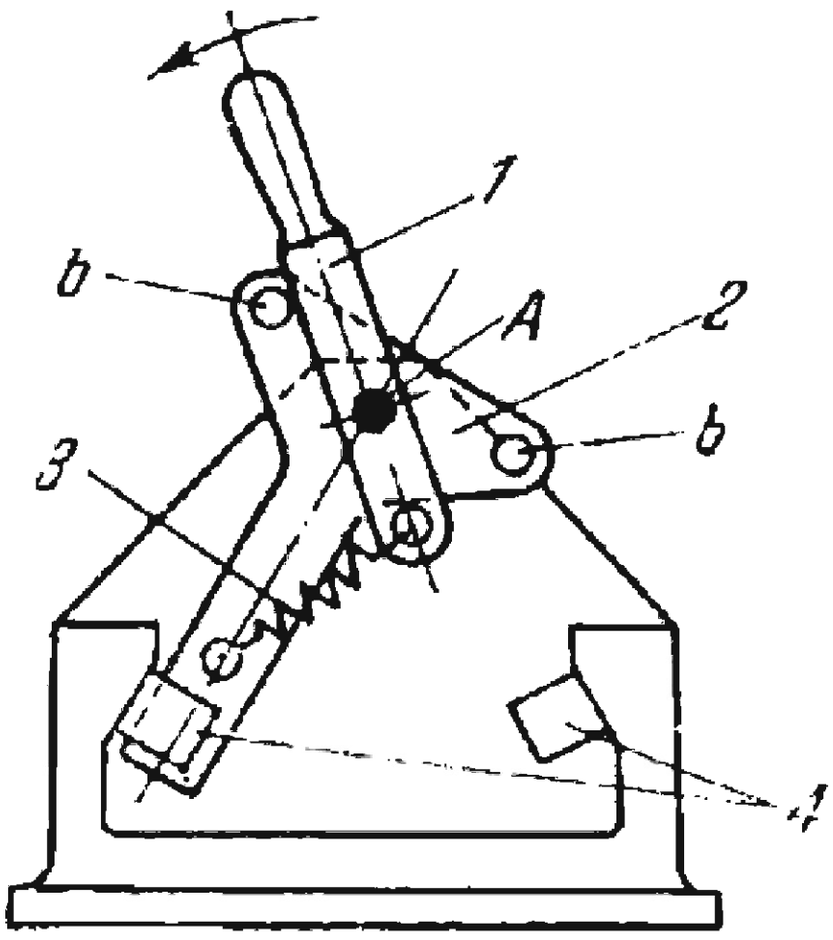
Rotation is transmitted between intersecting shafts *1* and *3* by elastic link *2*.

2129	SPRING-TYPE ELASTIC COUPLING	EL C



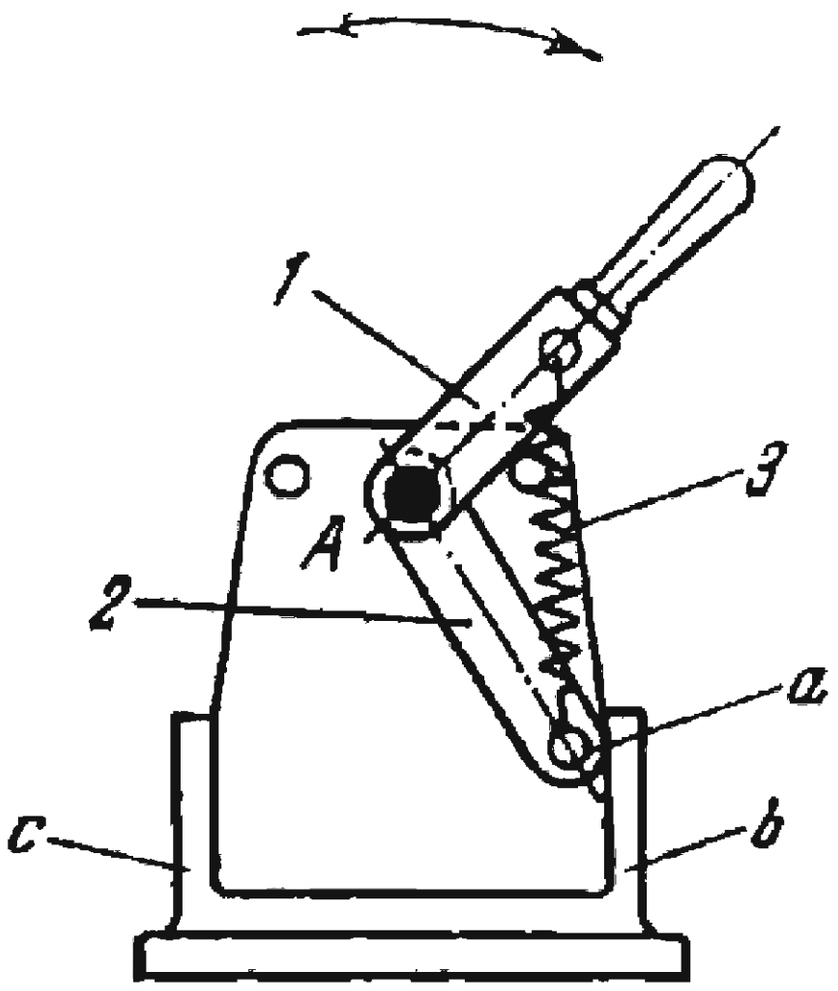
Disks *1* and *2*, keyed on the ends of two shafts, have lugs *a* and *b*, between which springs *3* are arranged. Rotation is transmitted from one shaft to the other through springs *3*.

2130	LEVER-TYPE ELASTIC-LINK SWITCHING MECHANISM	EL SE



Levers *1* and *2* turn about fixed axis *A*. When lever *1* is turned counterclockwise, spring *3* pulls lever *2* smoothly out of one of the clips *4*. If lever *2* sticks in a clip *4*, it can be positively extracted by turning lever *1* further so that it engages a pin *b* of lever *2*.

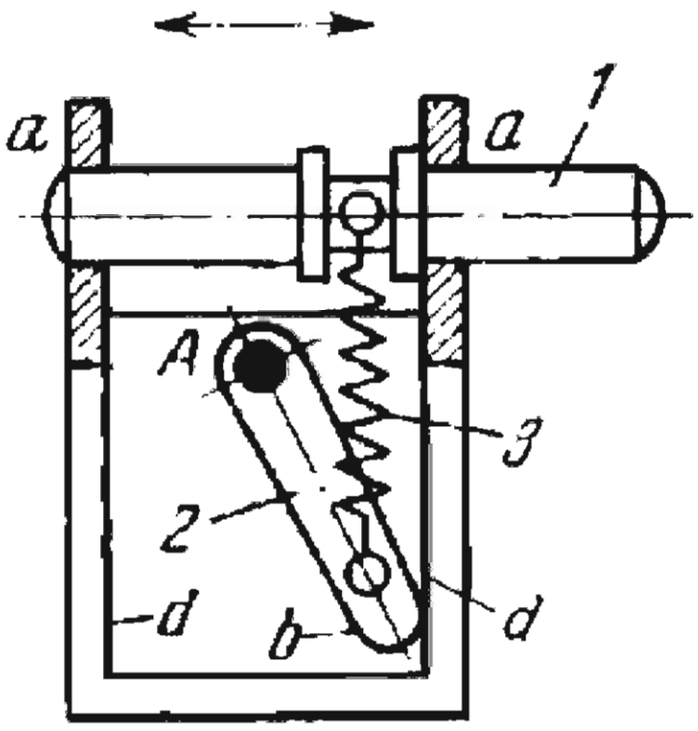
2131	LEVER-TYPE ELASTIC-LINK SWITCHING MECHANISM	EL SE



Levers *1* and *2* turn about fixed axis *A*. When lever *1* is turned, lever *2* remains with its end *a* pressed tight against projection *b* of the base until lever *1* reaches the position of maximum tension of spring *3*. After this, end *a* of link *2* is quickly flipped over to its other extreme position against projection *c* of the base.

2132 LEVER-TYPE SLIDING-BOLT SWITCHING MECHANISM

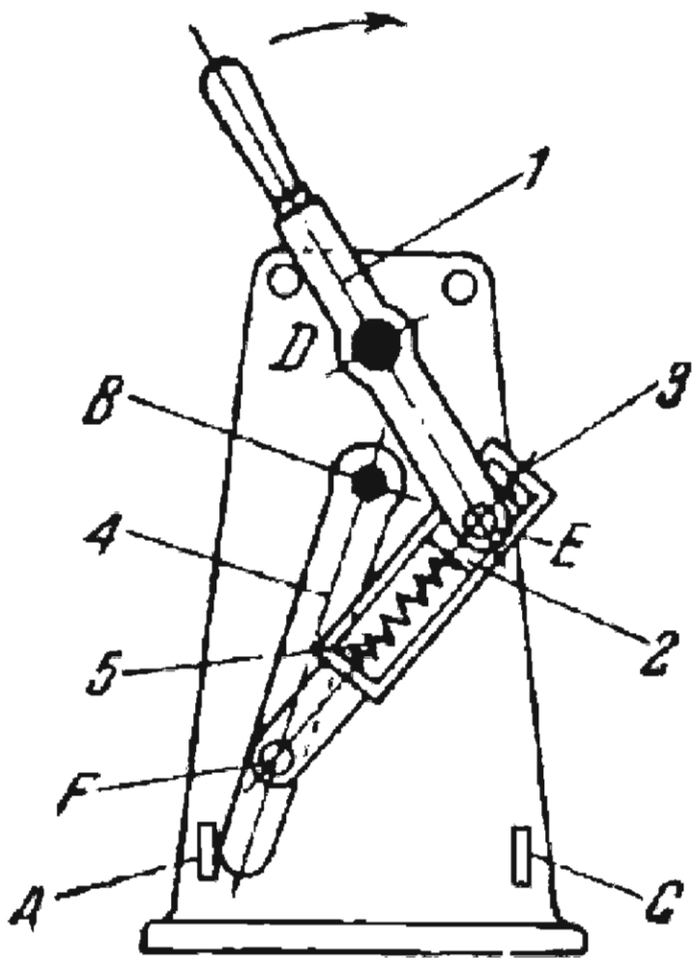
EL SE



Link (bolt) *1* slides in fixed guides *a-a*. Link *2* turns about fixed axis *A*. When bolt *1* moves from one extreme position to the other, link *2* remains with its end *b* pressed tight against one side *d* until bolt *1* reaches the position of maximum tension of spring *3*. After this, link *2* is quickly flipped over to its other extreme position with end *b* against the other side *d*.

2133 SLIDER-CRANK ELASTIC-LINK SWITCHING MECHANISM

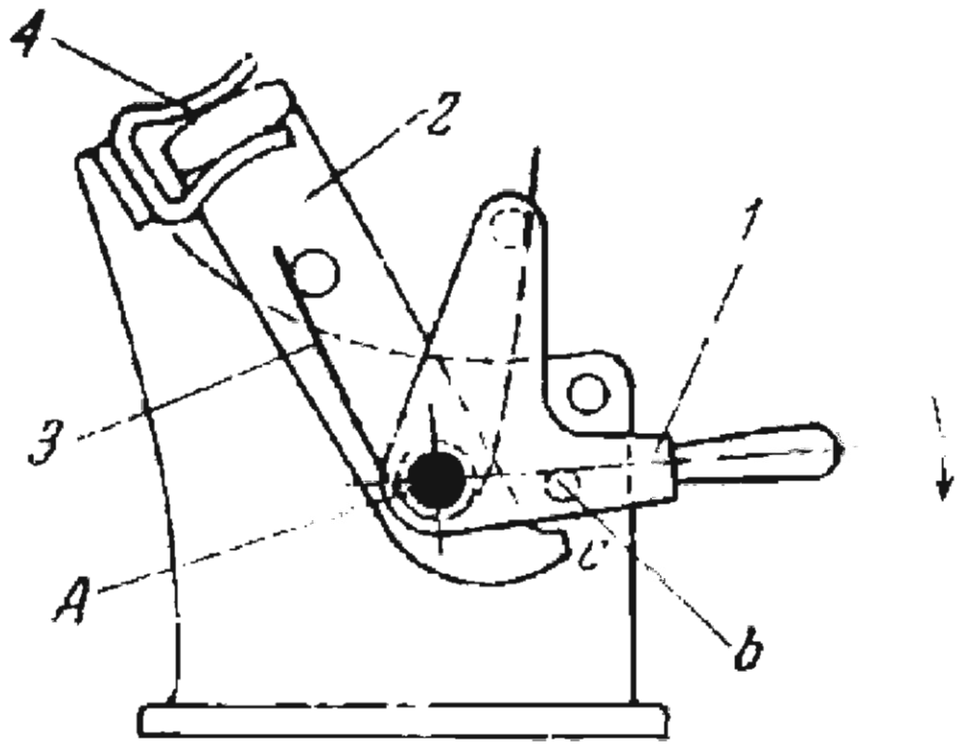
EL SE



Lever *1* turns about fixed axis *D* and is connected by turning pair *E* to slider *2* which moves along the slot in link *3*. Link *3* is connected by turning pair *F* to lever *4* which turns about fixed axis *B*. When lever *1* is turned clockwise, slider *2* moves along slotted link *3*, turning it with respect to centre *F* until lever *1* reaches its extreme right-hand position. After this, link *4*, actuated by spring *5*, is flipped about axis *B* to its position against stop *C*. When lever *1* is turned counter-clockwise link *4* is flipped to its position against stop *A*.

2134 LEVER-TYPE ELASTIC-LINK SWITCHING MECHANISM

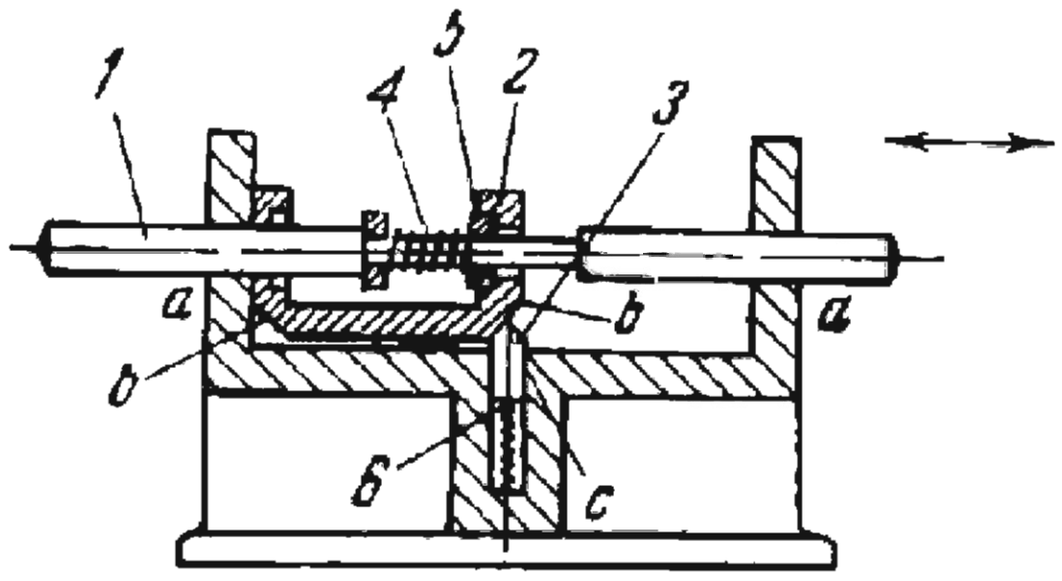
EL SE



Lever *1* and link *2* turn about fixed axis *A*. Elastic link *3* encircles shaft *A*. When lever *1* is turned clockwise, spring *3* pulls link *2* smoothly out of clip *4*. If link *2* sticks in clip *4*, it can be positively extracted by turning lever *1* further so that its pin *b* engages lug *c* of link *2*.

2135 BAR-TYPE ELASTIC-LINK SWITCHING MECHANISM

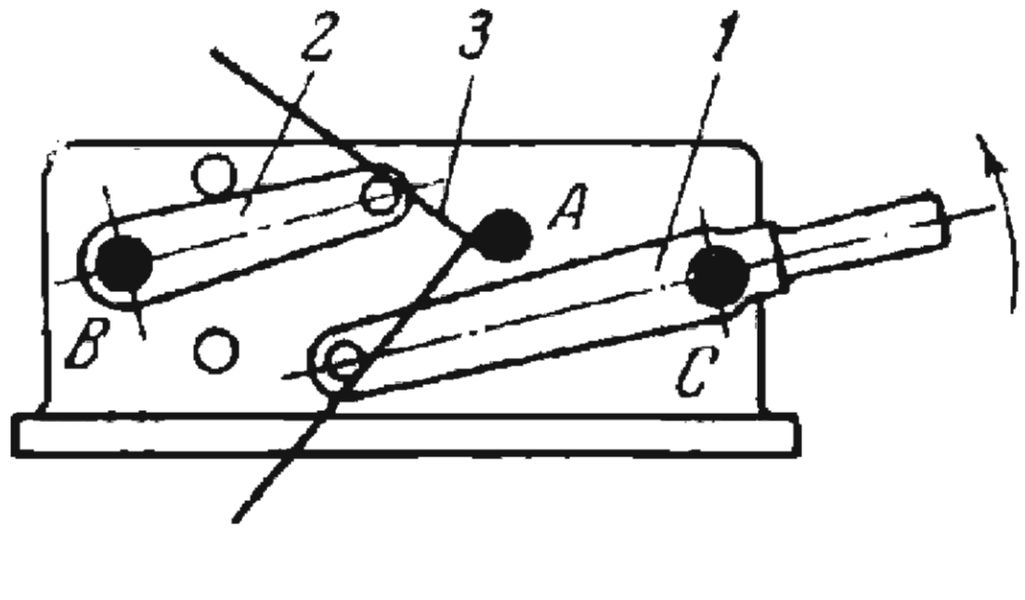
EL SE



Bar *1* slides in fixed guides *a-a*. Spring *4* is arranged between two washers *5* which slide freely along the middle part of bar *1* and are held by the spring against shoulders. Slider *2*, moving freely along bar *1*, has two bevels *b*. Pin *3*, spring-loaded by spring *6*, slides in fixed guides *c* and, engaging bevels *b*, indexes slider *2* in its extreme positions. When bar *1* is shifted to its other extreme position, spring *4*, overcoming the resistance of pin *3*, shifts slider *2* in the same direction to its other extreme position.

2136 LEVER-TYPE ELASTIC-LINK SWITCHING MECHANISM

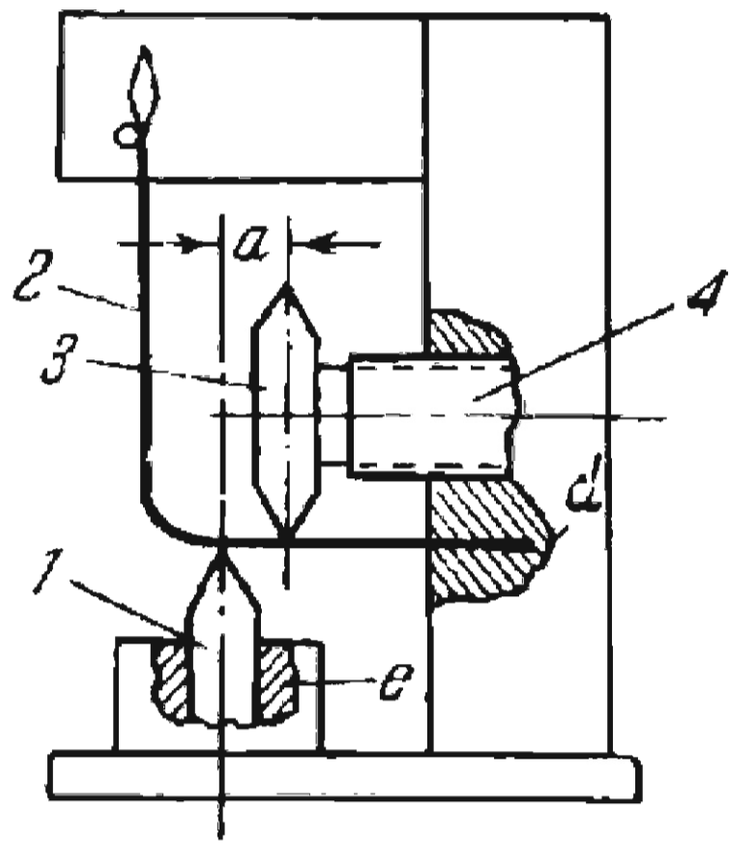
EL SE



Lever *1* turns about fixed axis *C* and lever *2* turns about fixed axis *B*. When lever *1* is turned, elastic link *3*, encircling fixed pin *A*, shifts lever *2* from one extreme position to the other.

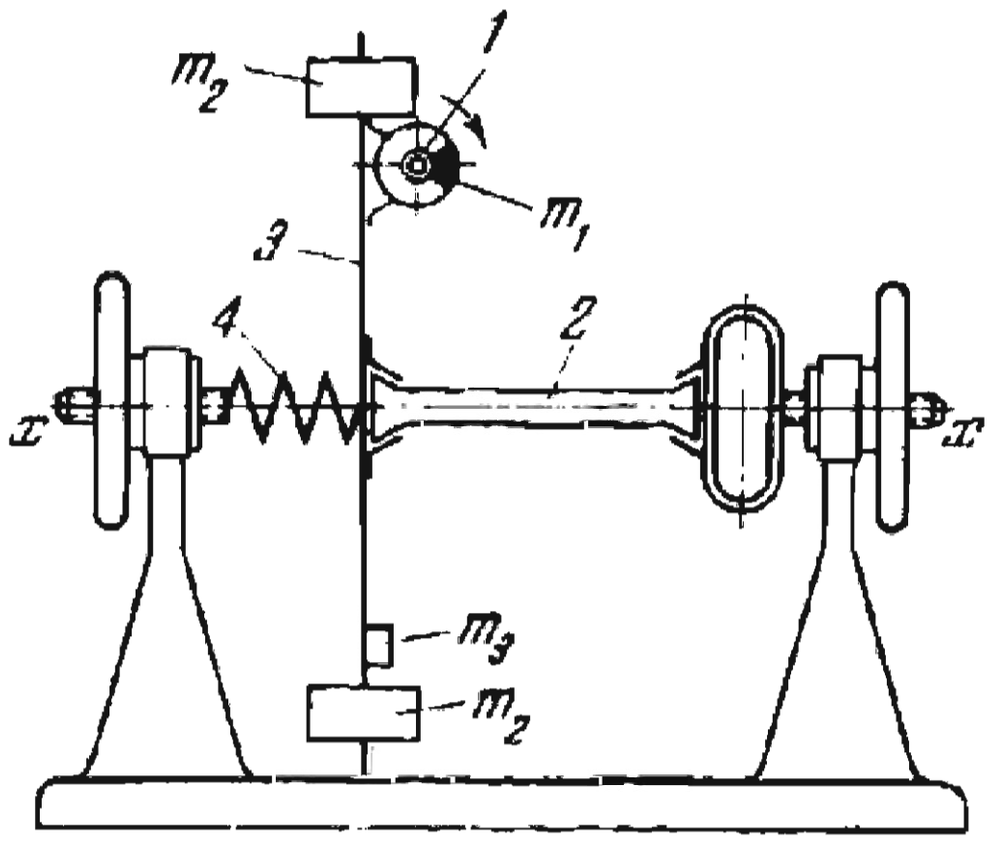
8. MECHANISMS OF MEASURING AND TESTING DEVICES (2137 through 2140)

2137	LEVER-TYPE ELASTIC-LINK MECHANISM OF A MEASURING INSTRUMENT	EL M



Pin *1* slides in fixed guide *e*. End *d* of hand *2* is fixed. When pin *1* moves up or down, hand *2* turns due to elastic strain of its portion *a*. The deviation of the hand can be varied by adjusting stop *3* with screw *4*.

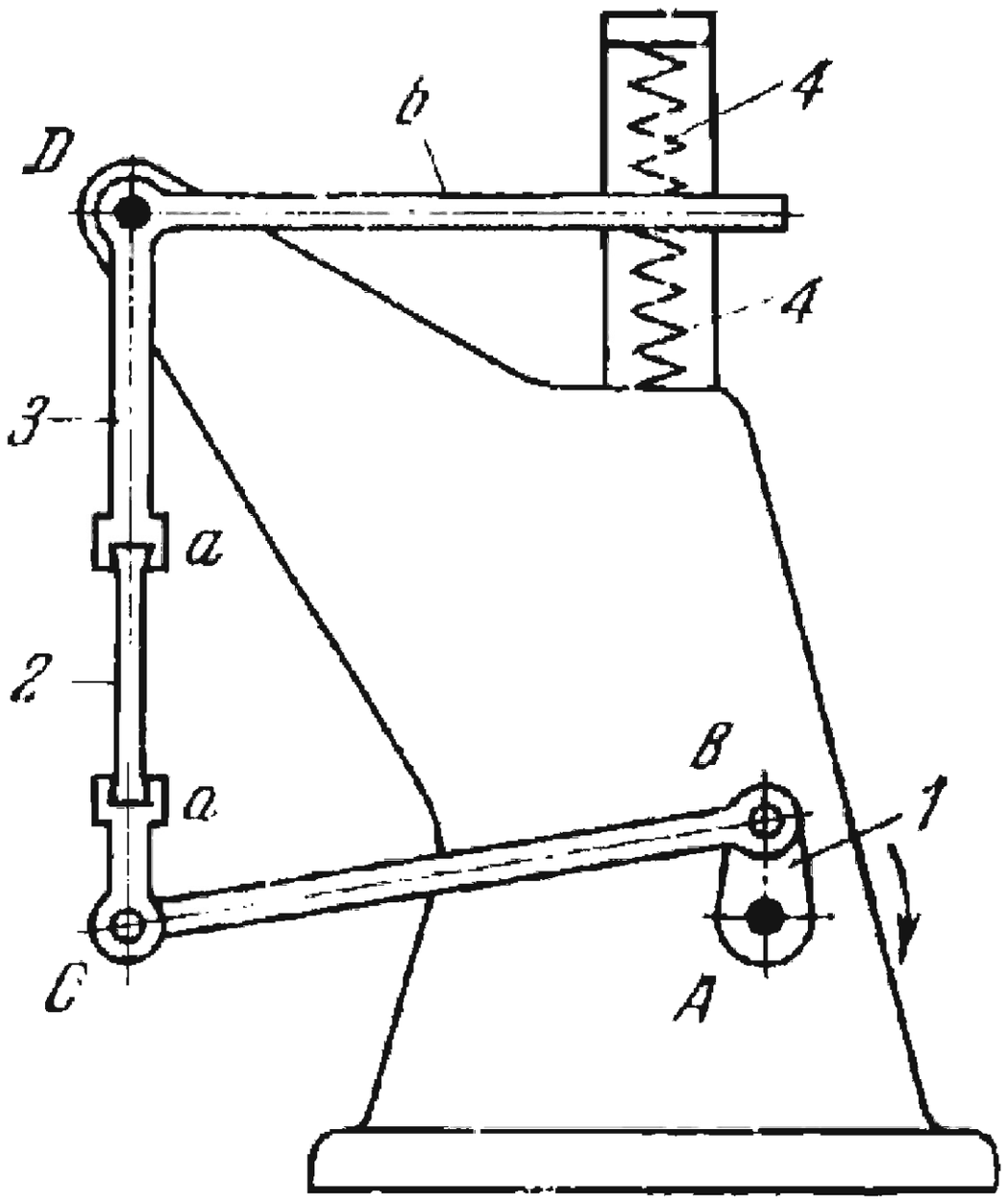
2138	LEVER-TYPE ELASTIC-LINK MECHANISM FOR A DYNAMIC TESTING DEVICE	El. M



Mounted on flat spring *3* are masses m_2, shaft *1* with unbalanced mass m_1 and mass m_3. Masses m_1, m_2 and m_3 are selected so that when shaft *1* rotates, the two overhanging ends of spring *3* vibrate in phase and with the same amplitude. This applies an alternating load to test-piece *2* along axis *x-x*. The magnitude of the load is regulated by means of spring *4*.

2139 LINKWORK MECHANISM WITH AN ELASTIC LINK FOR ALTERNATING BENDING TESTS

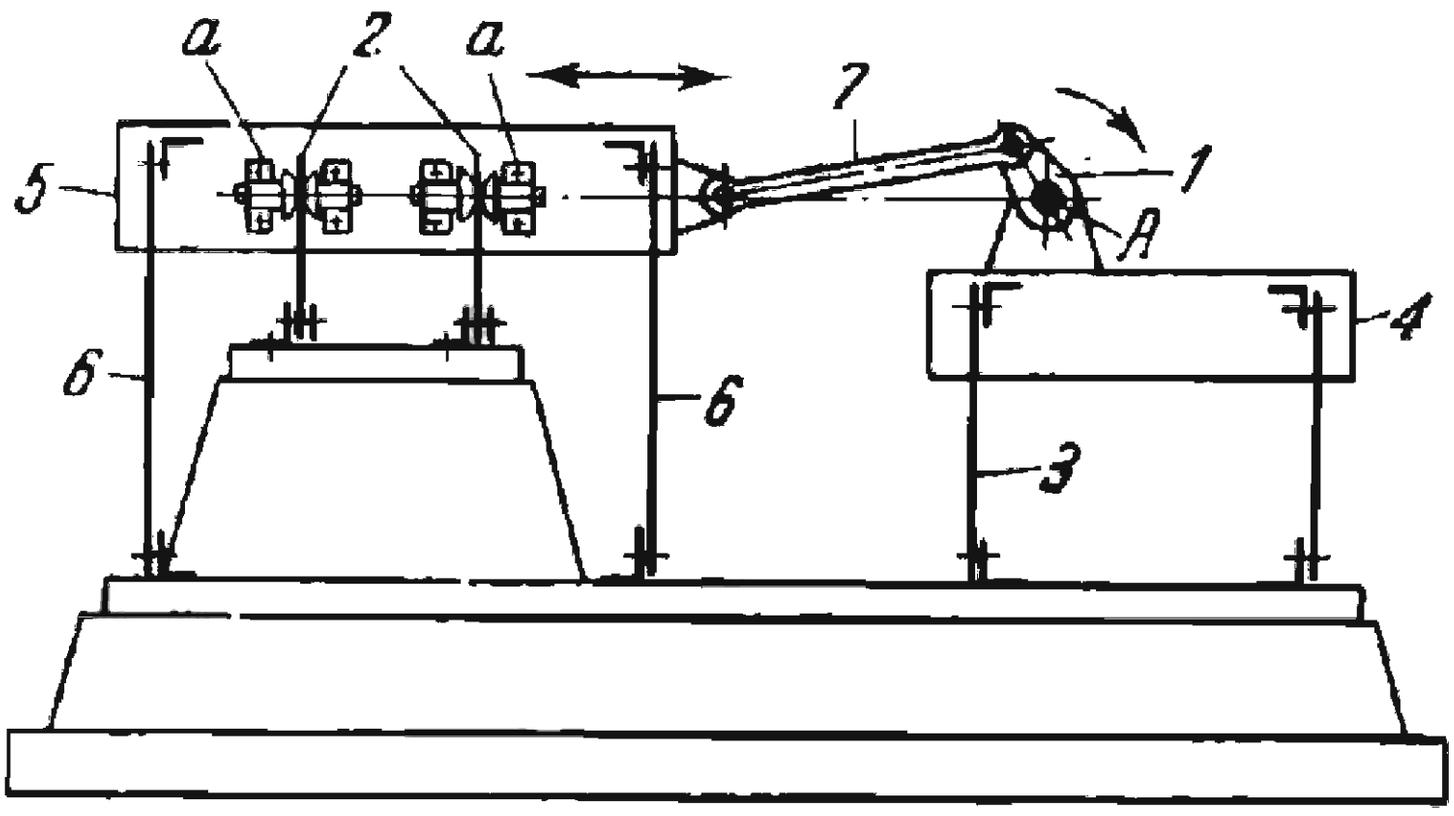
El M



Test-piece *2* is clamped in grips *a* of connecting rod *3* of four-bar linkage *ABCD*. When crank *1* rotates about fixed axis *A*, an alternating bending load is applied to the test-piece. Link *3* has extension *b* which is spring-loaded by springs *4*.

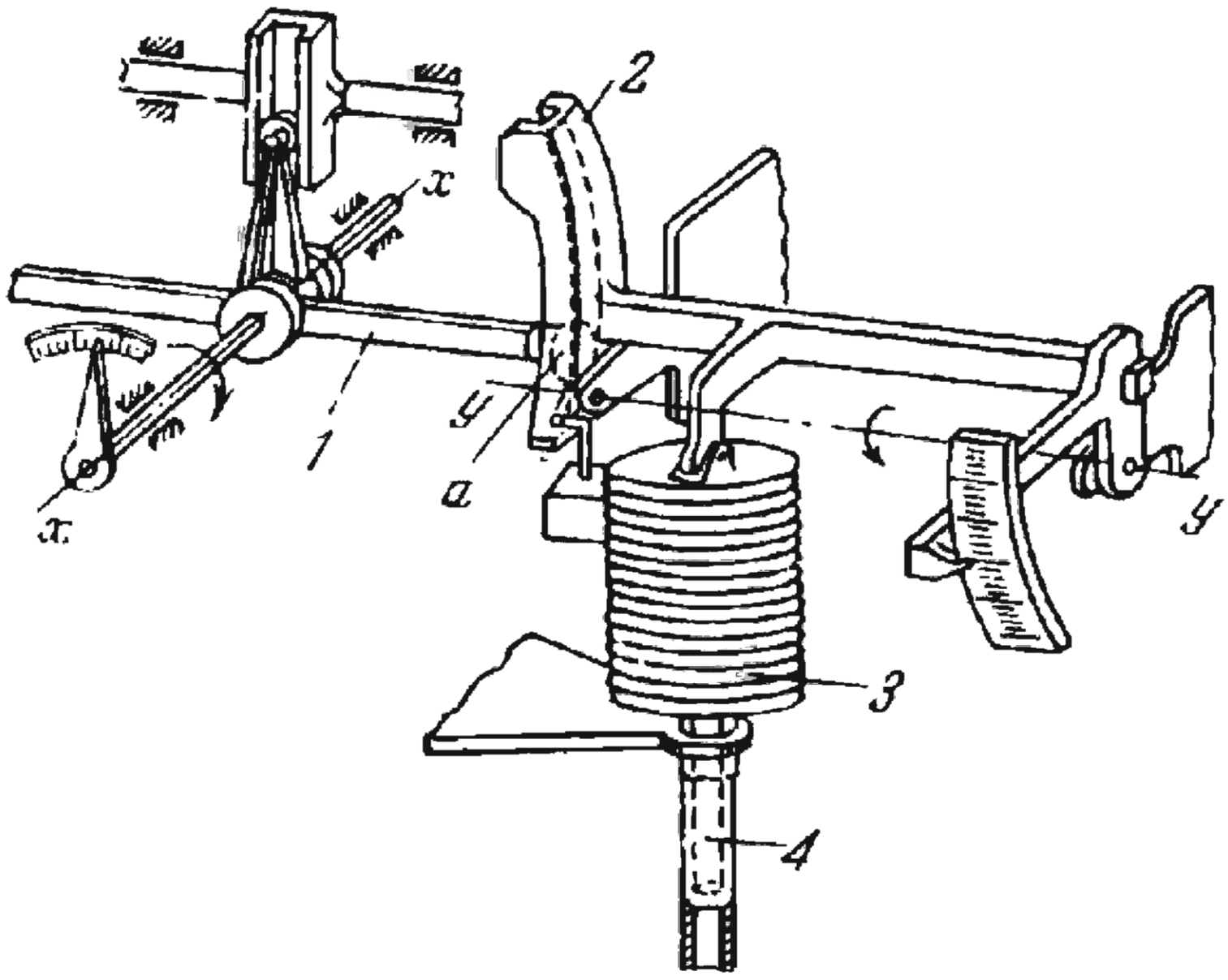
2140 SLIDER-CRANK ELASTIC-LINK MECHANISM FOR TESTING FLAT SPRINGS

El M



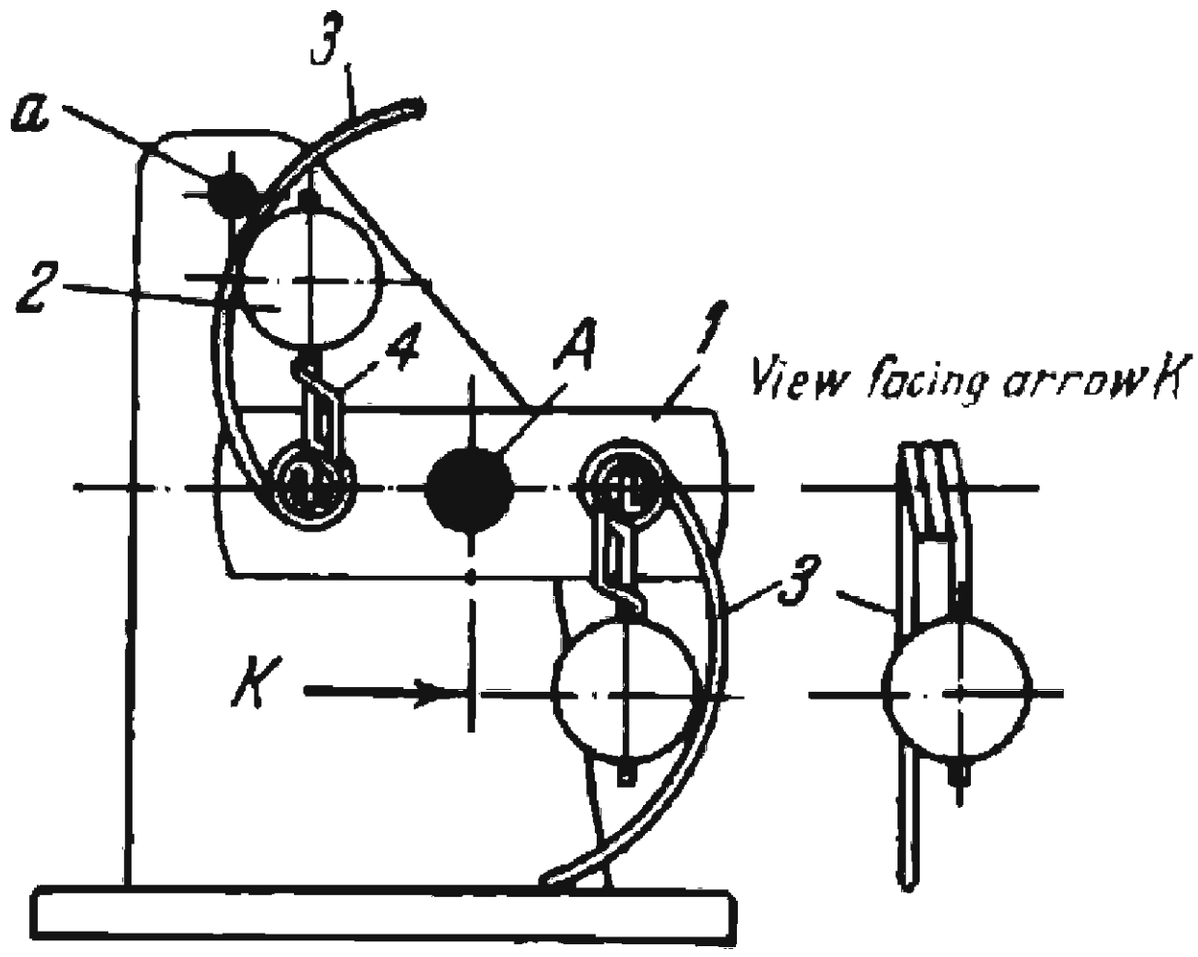
Crank *1* rotates about fixed axis *A* of platform *4* which is mounted on flat springs *3*. Connecting rod *7* drives platform *5* which is mounted on long flat springs *6*. Flat springs *2* which are to be tested are secured with one end in the fixed foundation and the other end in a grip *a* of platform *5*. When crank *1* rotates, springs *2* have an elastic oscillating motion.

2141	LINK-GEAR MULTIPLIER MECHANISM WITH AN ELASTIC LINK	EL MO



The mechanism determines the product *zu*. Variable *z* is entered by turning flat spring *1* about axis *x-x*. Grooved member *2* is turned about axis *y-y* by sylphon bellows *3* into which air is admitted through tube *4*. The pressure of this air is the second multiplier *u*. The force developed by the pressure in bellows *3* is counterbalanced by the elastic resistance of spring *1* in torsion. Inversely, when spring *1* is turned, grooved member *2*, in whose groove roller *a* slides, is turned until the elastic force of spring *1* is counterbalanced by the force developed in sylphon bellows *3*. Thus the whole mechanism is always in a state of elastic equilibrium and the total angle of rotation of member *2* about axis *y-y* is proportional to the product *zu*.

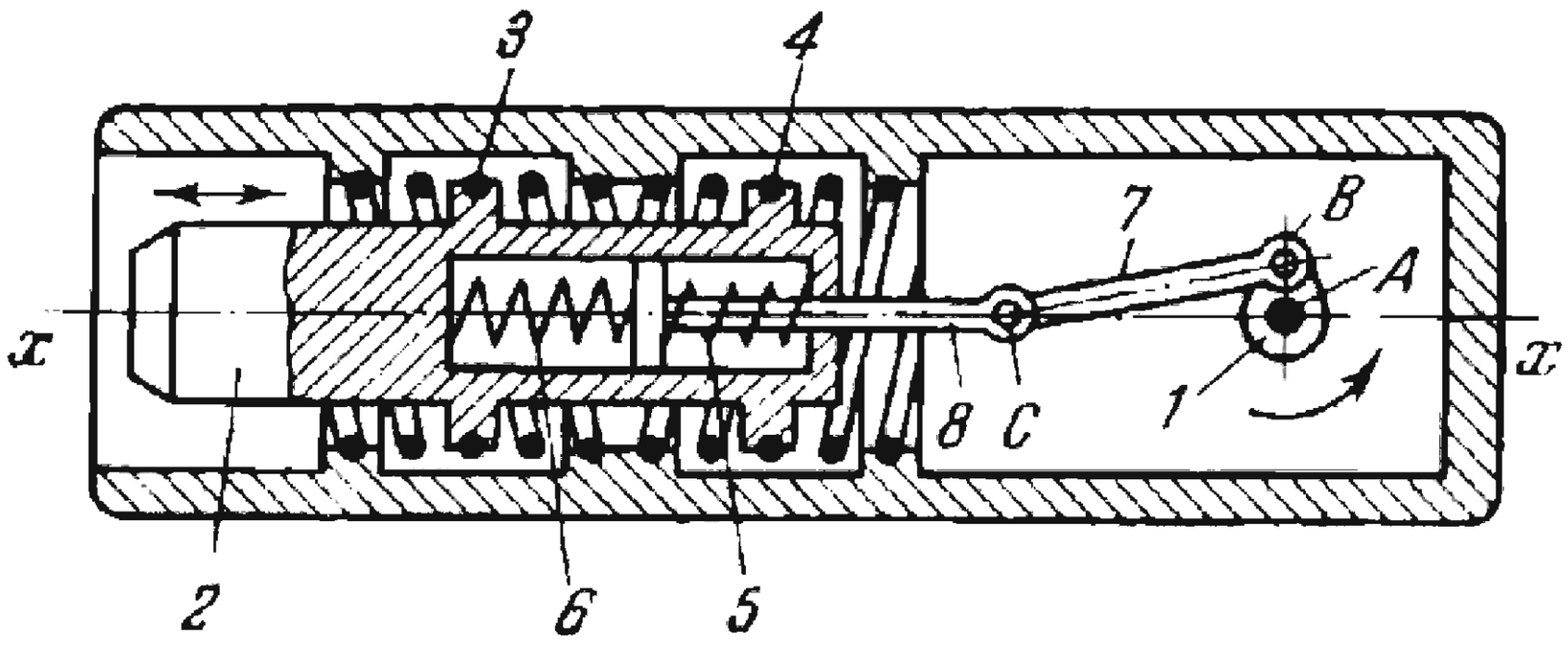
2142	LEVER-TYPE CENTRIFUGAL GOVERNOR WITH IMPACT-ACTION ELASTIC LINKS	EL G



Link *1* rotates about fixed axis *A*. At this, weights *2*, mounted on springs *3*, are turned outward by centrifugal force so that springs *3* bump against pin *a* thereby braking link *1*. Torsion springs *4* return weights *2* to their initial position when the speed of rotation of link *1* decreases.

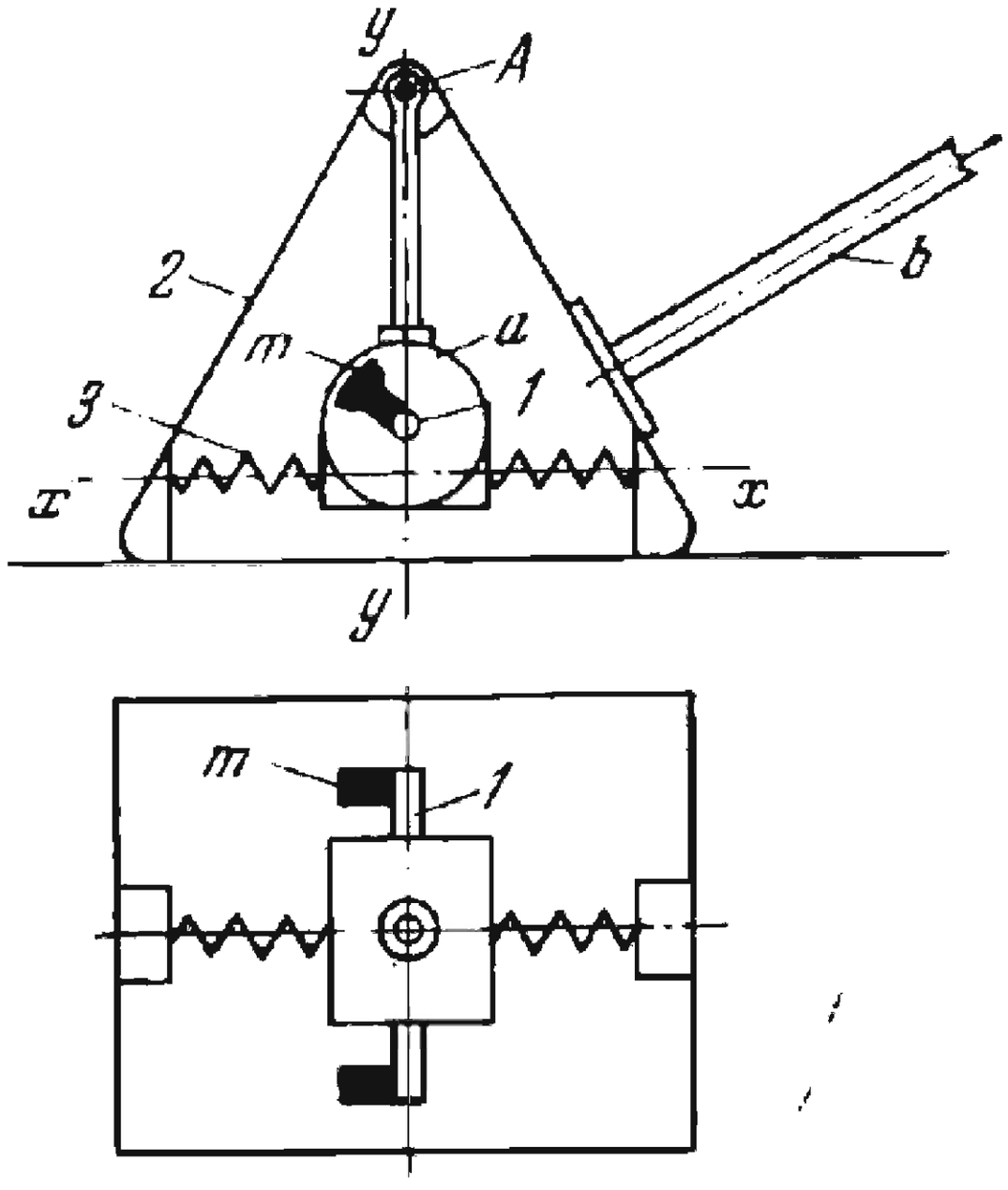
11. MECHANISMS OF VIBRATING MACHINES AND DEVICES (2143 through 2158)

2143	SLIDER-CRANK ELASTIC-LINK MECHANISM OF A PORTABLE SPRING HAMMER	EL VM

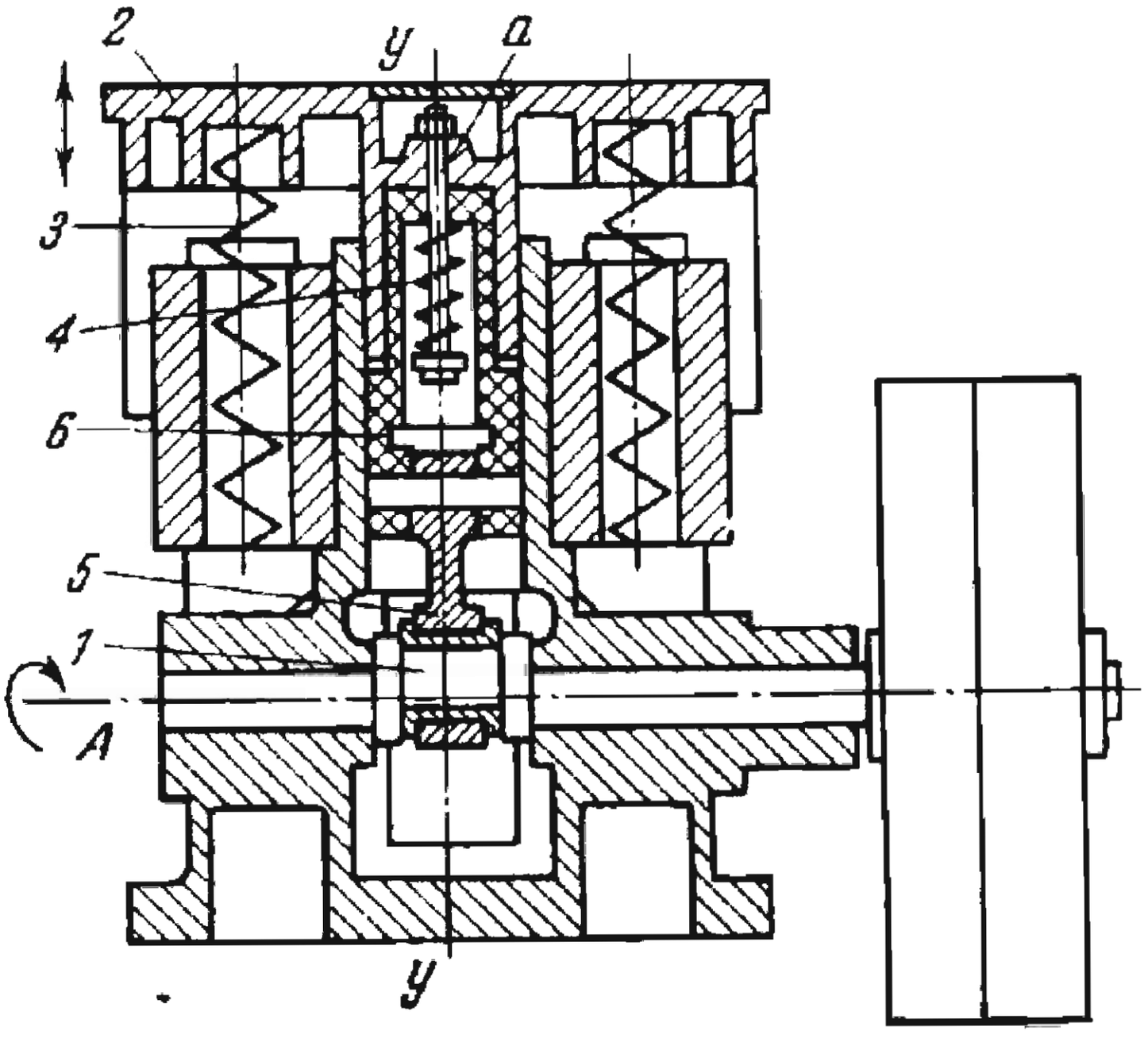


Crank *1* rotates about fixed axis *A* of the hammer housing. Connecting rod *7* is connected by turning pairs *B* and *C* to crank *1* and to slider *8* which is connected by springs *5* and *6* to striker *2*. Two helical springs, *3* and *4*, serve as the guides of striker *2*. When crank *1* rotates, striker *2* of the hammer has a vibratory motion along axis *x*-*x* due to the action of springs *3*, *4*, *5* and *6*.

2144	LEVER-TYPE ELASTIC-LINK RAMMER MECHANISM	EL VM

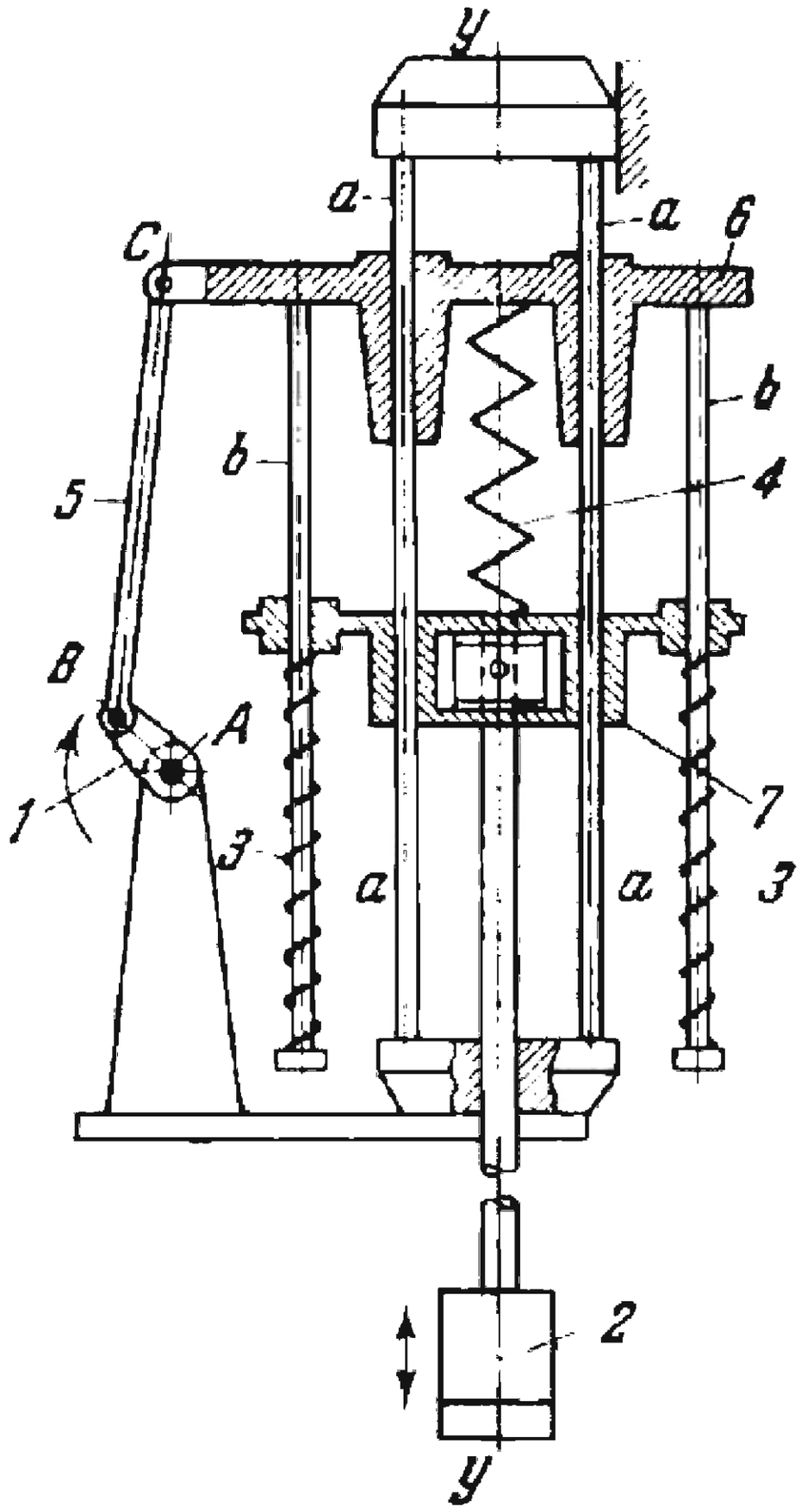


Electric motor *a* is connected by turning pair *A* to housing *2* of the rammer. Unbalanced masses *m* are mounted on the motor shaft. When shaft *1* of motor *a* rotates, the components of the unbalanced forces in the direction along axis *x*-*x* are transmitted by springs *3* to lever *b* which holds housing *2* against the material being rammed. The ramming action is due to the components of the unbalanced forces in the direction of axis *y*-*y*.



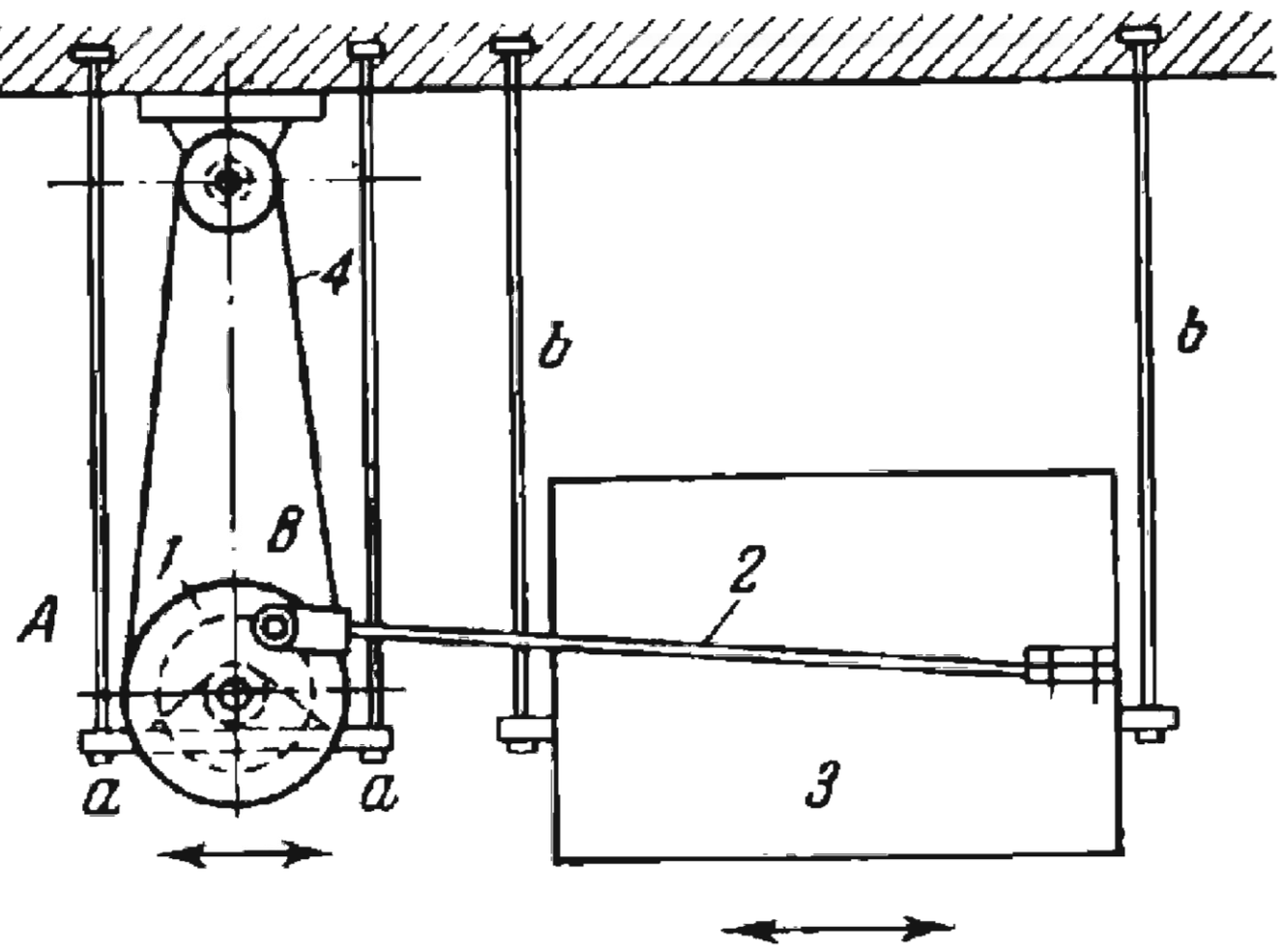
Crank *1* rotates about fixed axis *A*. Connecting rod *5* is connected by turning pairs to crank *1* and to slider *6* which reciprocates in fixed guides. Table *2* slides along fixed guides and along slider *6*. Table *2* is connected to the base by springs *3* and to slider *6* by spring *4* which is coiled on rod *a*. Rod *a* joins table *2* and slider *6*. When crank *1* rotates, table *2* has a vertical vibratory motion along axis *y-y* due to the action of springs *3* and *4*.

2146	SLIDER-CRANK ELASTIC-LINK RAMMER MECHANISM	EL VM



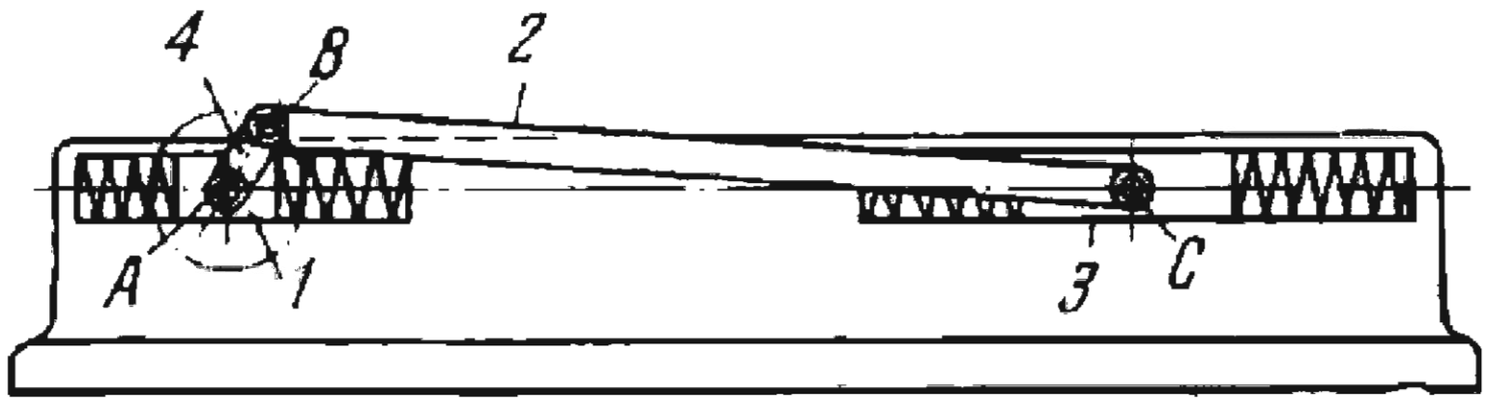
Crank *1* rotates about fixed axis *A*. Connecting rod *5* is connected by turning pairs *B* and *C* to crank *1* and to frame *6* which slides along fixed guides *a-a*. Frame *6* has rods *b*. Movable frame *7* slides along fixed guides *a-a* and rods *b*. Spring *4* of frame *7* is connected to frame *6*, and springs *3* spring-load frame *7* as it slides along rods *b*. Rigidly attached to frame *7* is rammer *2* which vibrates along axis *y-y* due to the action of springs *3* and *4* when crank *1* rotates.

2147	LINKWORK FLAT SCREENING MECHANISM WITH ELASTIC LINKS	EL VM



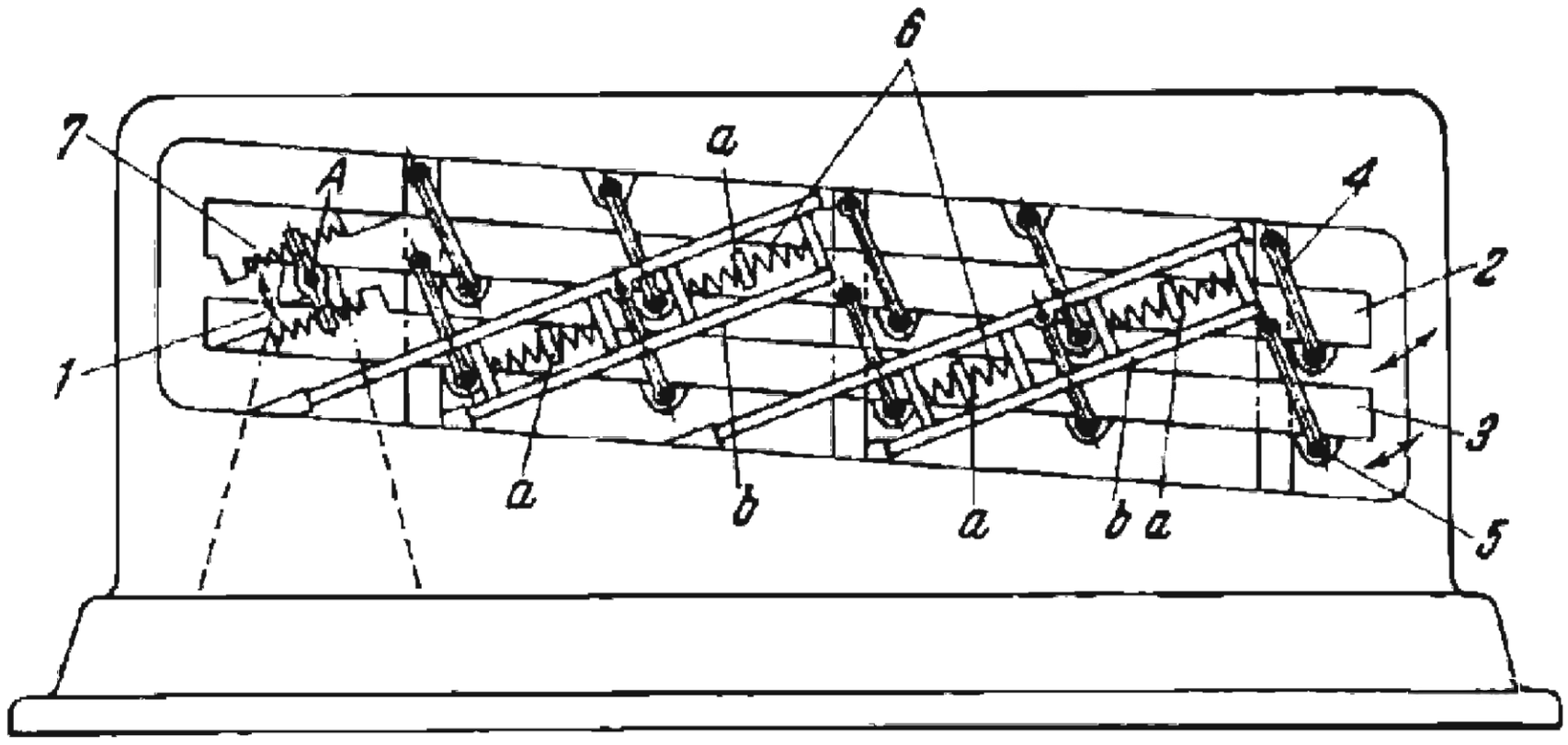
Screening device *3* is suspended from flat springs *b* and is driven by crank *1* through connecting rod *2*. Crank *1* and bearing *A* are suspended from flat springs *a*. The crank is driven by belt *4*.

2148	SLIDER-CRANK ELASTIC-LINK FLAT SCREENING MECHANISM	EL VM



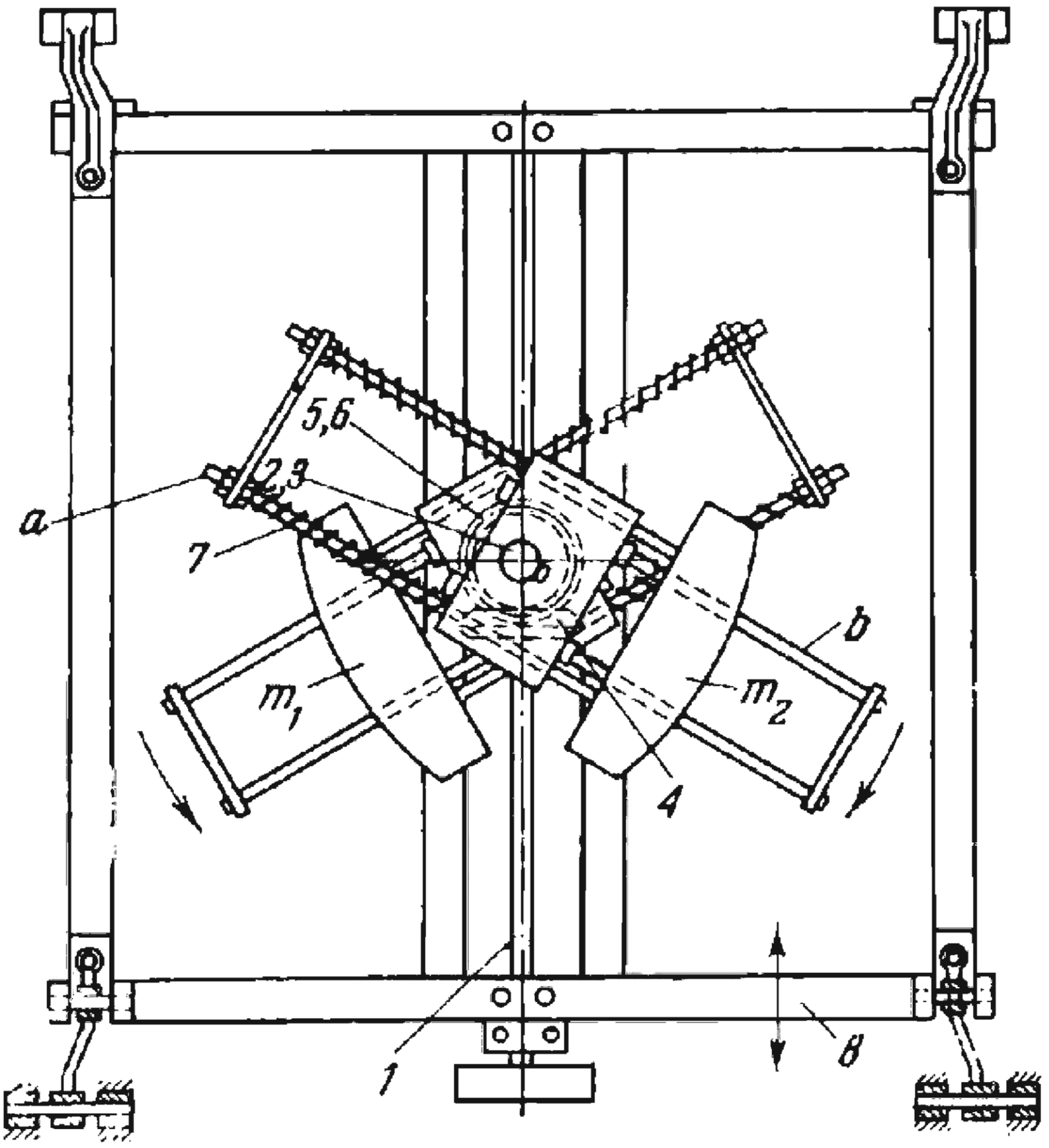
The screens (not shown) are rigidly attached to sliders *1* and *3*. When crank *4* rotates, the sliders have vibratory motions. Crank *4* is driven by a flexible shaft.

2149	LINKWORK SCREENING MECHANISM WITH ELASTIC LINKS	EL VM



The frame of screen *2* is suspended from the upright by identical parallel suspension links *4*. The frame of screen *3* is suspended from the upright by identical parallel suspension links *5*. Screens *2* and *3* have lugs *a*. Springs *6* are arranged between lugs *a* and fixed frames *b*. Vibratory motion is imparted to the mechanism by rocker arm *1*, oscillating about fixed axis *A* and actuating springs *7* which are connected to the frames of screens *2* and *3*. When rocker arm *1* oscillates, screens *2* and *3* have vibratory motions.

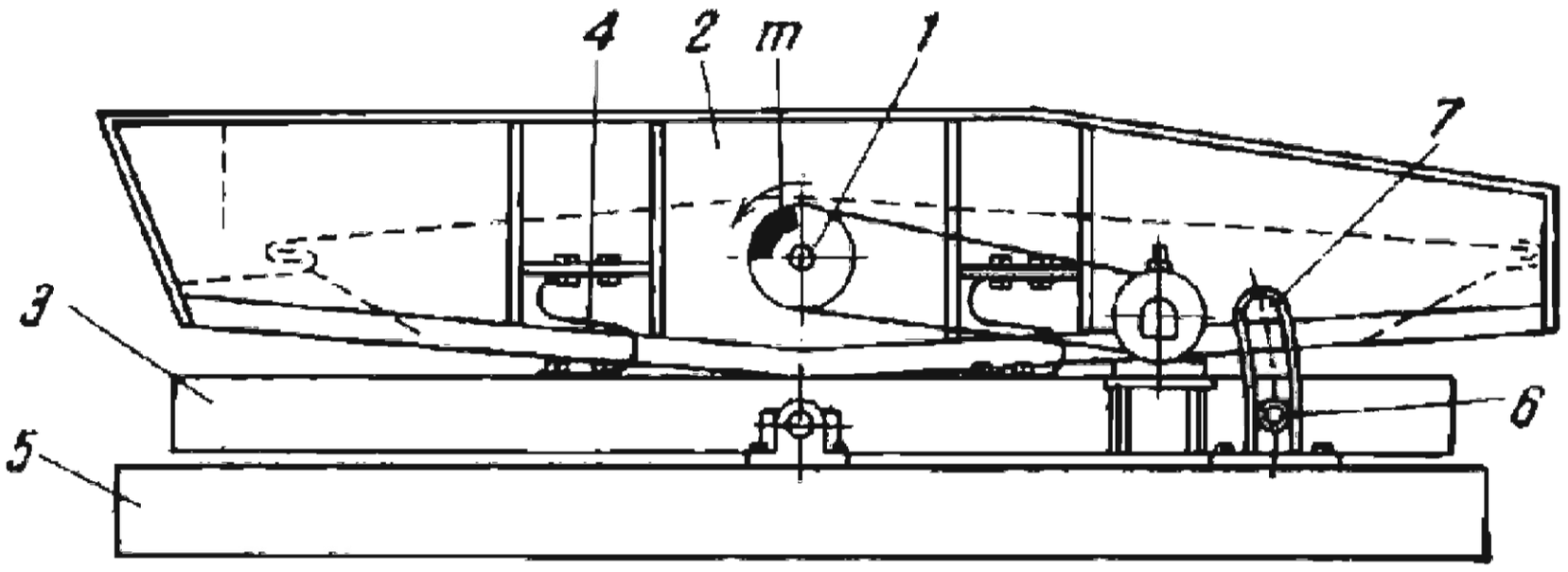
2150	SCREEN FRAME DRIVE MECHANISM WITH ELASTIC LINKS	EL VM



Rotation is transmitted from shaft *1* to shafts *2* and *3* through bevel gears *4*, *5* and *6*. Masses m_1 and m_2 are mounted on shafts *2* and *3* by means of guides *a* and *b* and springs *7*. Masses m_1 and m_2, together with their guides, rotate in opposite directions. By the action of unbalanced masses m_1 and m_2, frame *8* of the screen has vibratory motion in the direction shown by the arrow.

2151 ELASTIC-LINK SCREENING MECHANISM

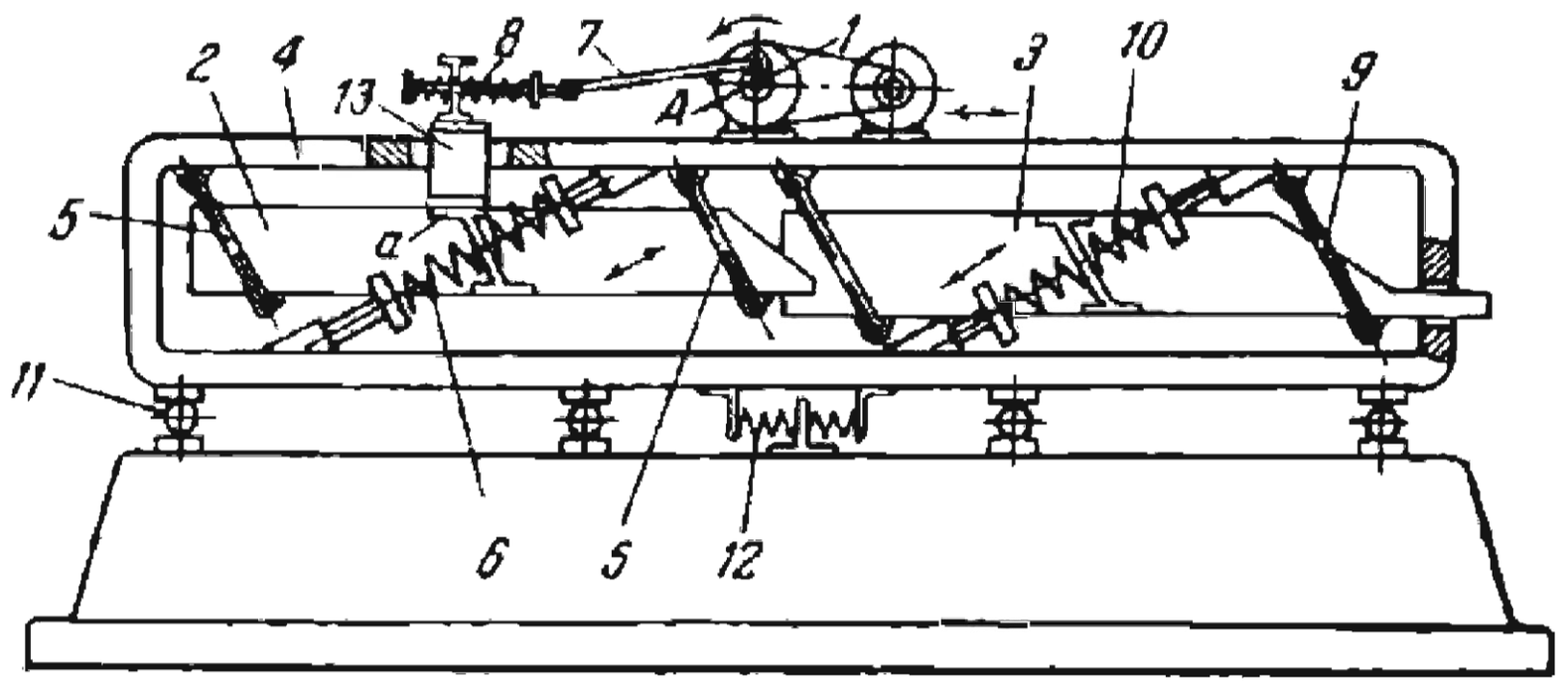
EL VM



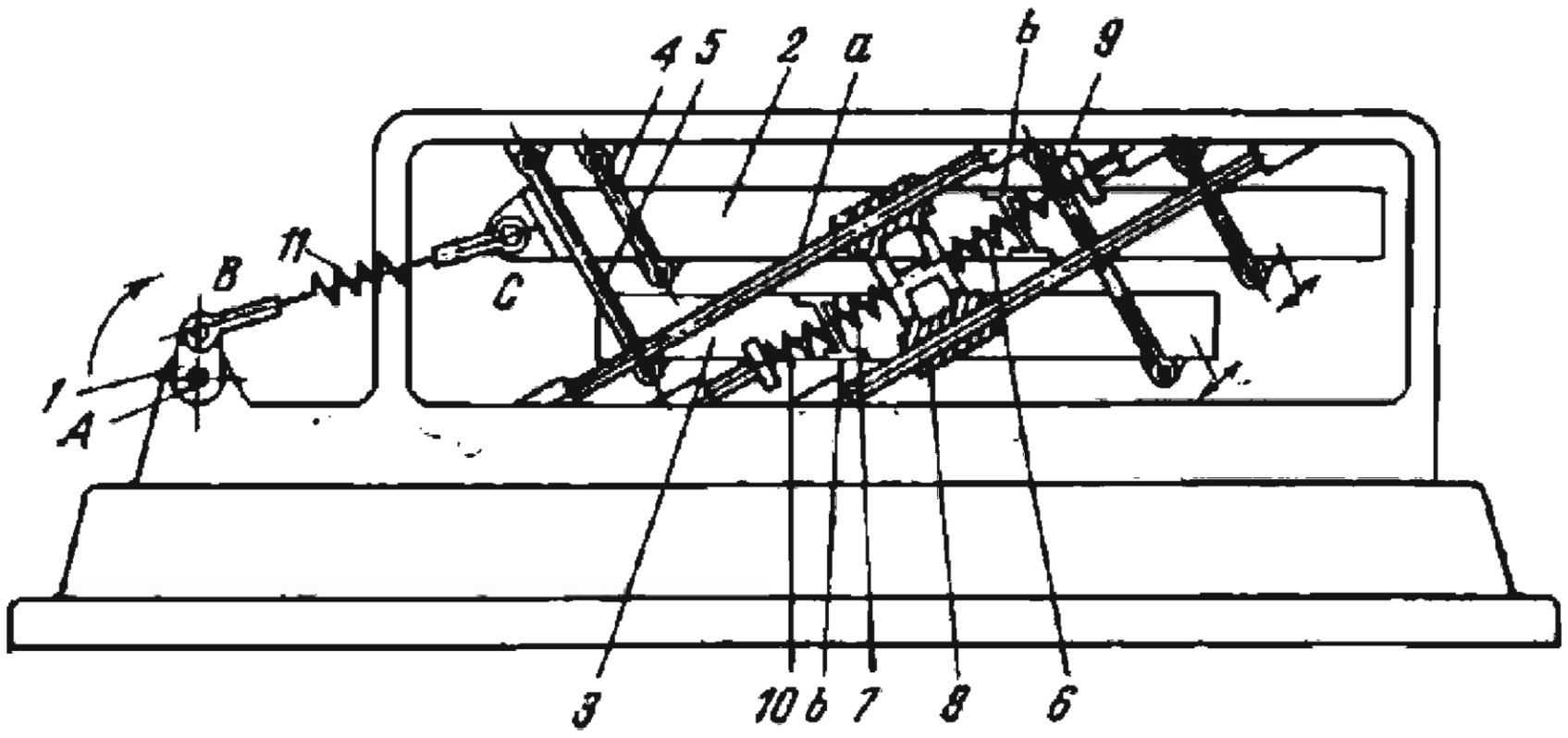
Frame *3* of the screen is clamped on fixed frame *5* by bolt *6* which can be adjusted along circular guide *7* and clamped with the screen inclined at the required angle. Body *2* of the screen is connected to frame *3* by four S-shaped springs *4*. Mounted on shaft *1* of body *2* is unbalanced mass *m*. When shaft *1* rotates, the body of the screen has a vibratory motion due to the action of unbalanced mass *m* and springs *4*.

2152 SLIDER-CRANK ELASTIC-LINK SCREENING MECHANISM

EL VM

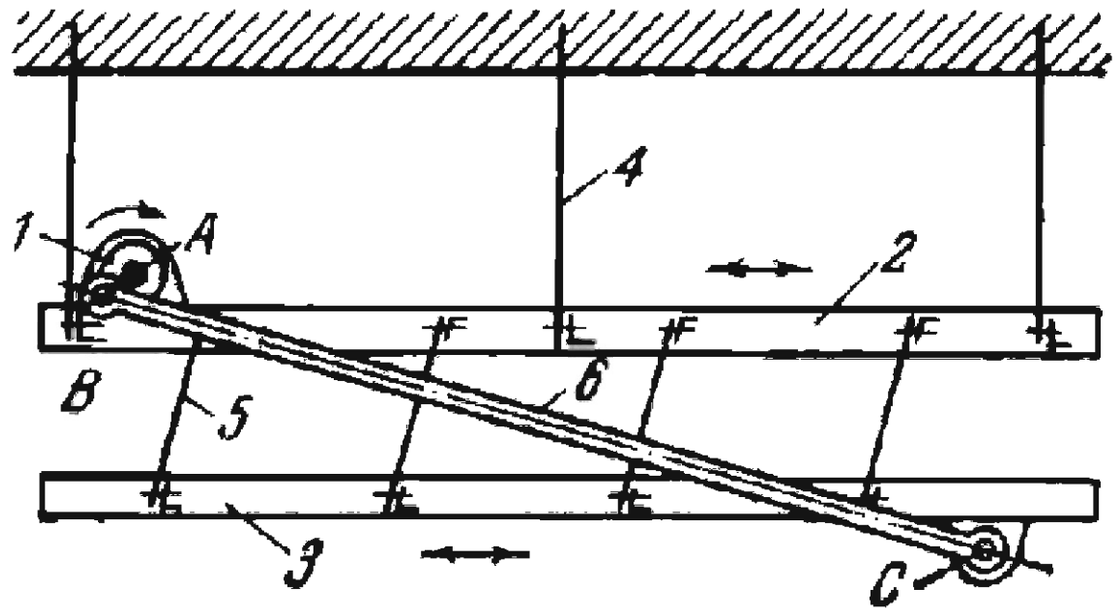


Crank *1* rotates about axis *A* of movable frame *4*. Slider *13* moves in the guides of the frame of screen *2* and is spring-loaded by spring *8*. The frame of screen *2* is suspended from frame *4* by suspension links *5*, pivoted to the frame. The frame of screen *2* has bracket *a*. Frames *2* and *4* are spring-loaded by springs *6*. The frame of screen *3*, suspended by links *9*, is spring-loaded by springs *10*. Movable frame *4* rests on rollers *11* and is connected to the foundation by springs *12*. When crank *1* rotates, screens *2* and *3* have complex vibratory motions.



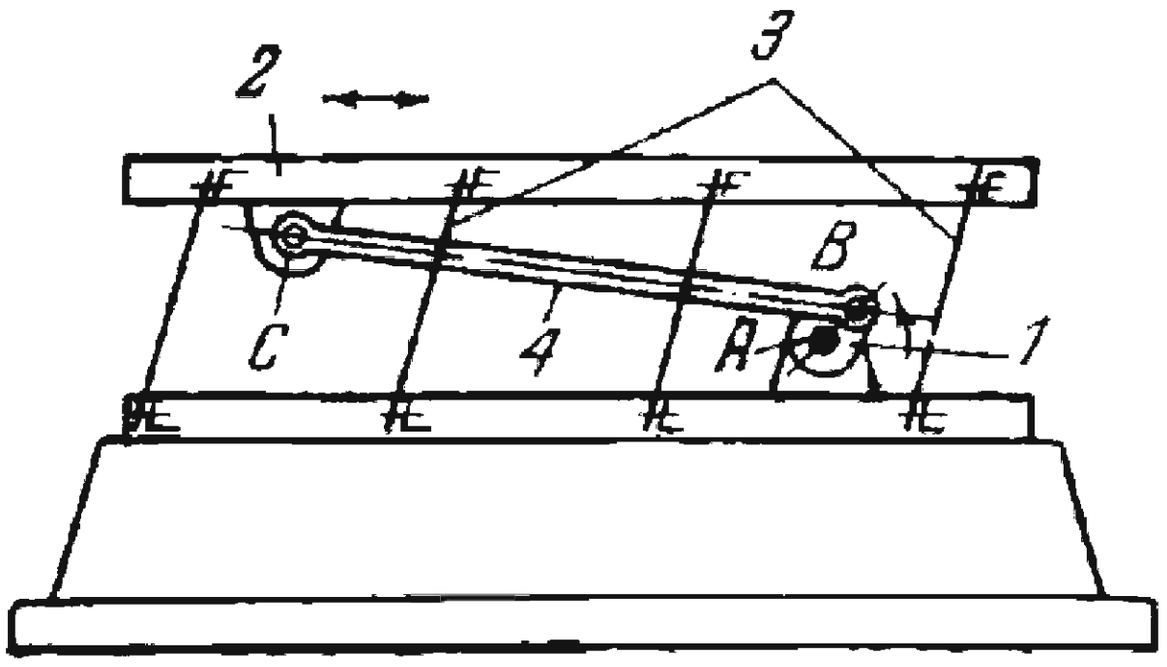
Crank *1* rotates about fixed axis *A*. The frame of screen *2*, suspended on links *4*, is connected to crank *1* by spring *11*. The frame of screen *3* is suspended from links *5*. Slider *8* moves along fixed guides *a*. The frames of screens *2* and *3* have brackets *b*. The frames of screens *2* and *3* and slider *8* are spring-loaded by springs *6*, *7*, *9* and *10*. When crank *1* rotates, screens *2* and *3* have complex vibratory motions.

2154	LINKWORK SIFTER MECHANISM WITH ELASTIC LINKS	EL VM

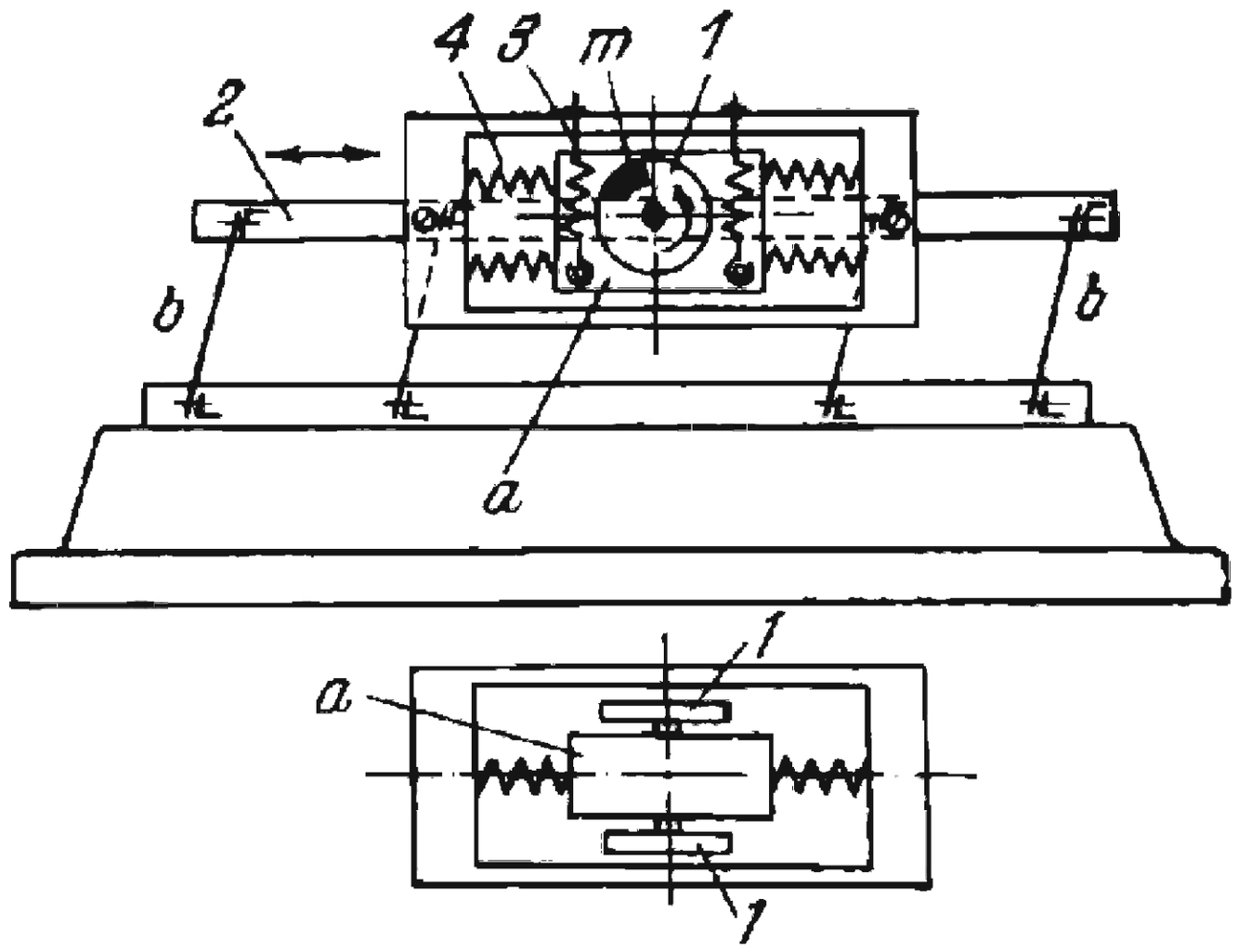


Crank *1* rotates about fixed axis *A* of frame *2* which is suspended from the base by flat springs. Connecting rod *6* is connected by turning pairs *B* and *C* to crank *1* and to frame *3* which is suspended from frame *2* by flat springs *5*. When crank *1* rotates, frames *2* and *3* have vibratory motions.

2155	ELASTIC-LINK SIFTER MECHANISM	EL VM

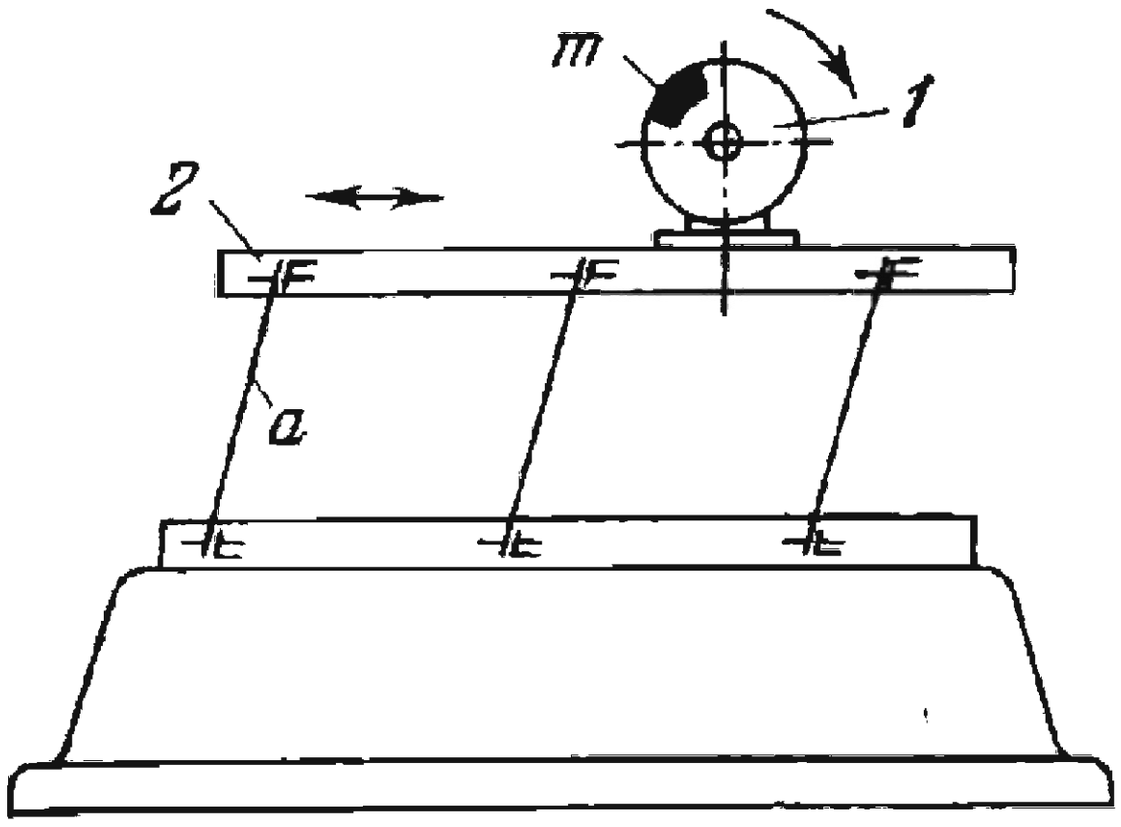


Connecting rod *4* is connected by turning pair *B* to crank *1*, rotating about fixed axis *A*, and by turning pair *C* to frame *2*. Frame *2* is connected to the base by flat springs *3*. When crank *1* rotates, frame *2* has a vibratory motion.



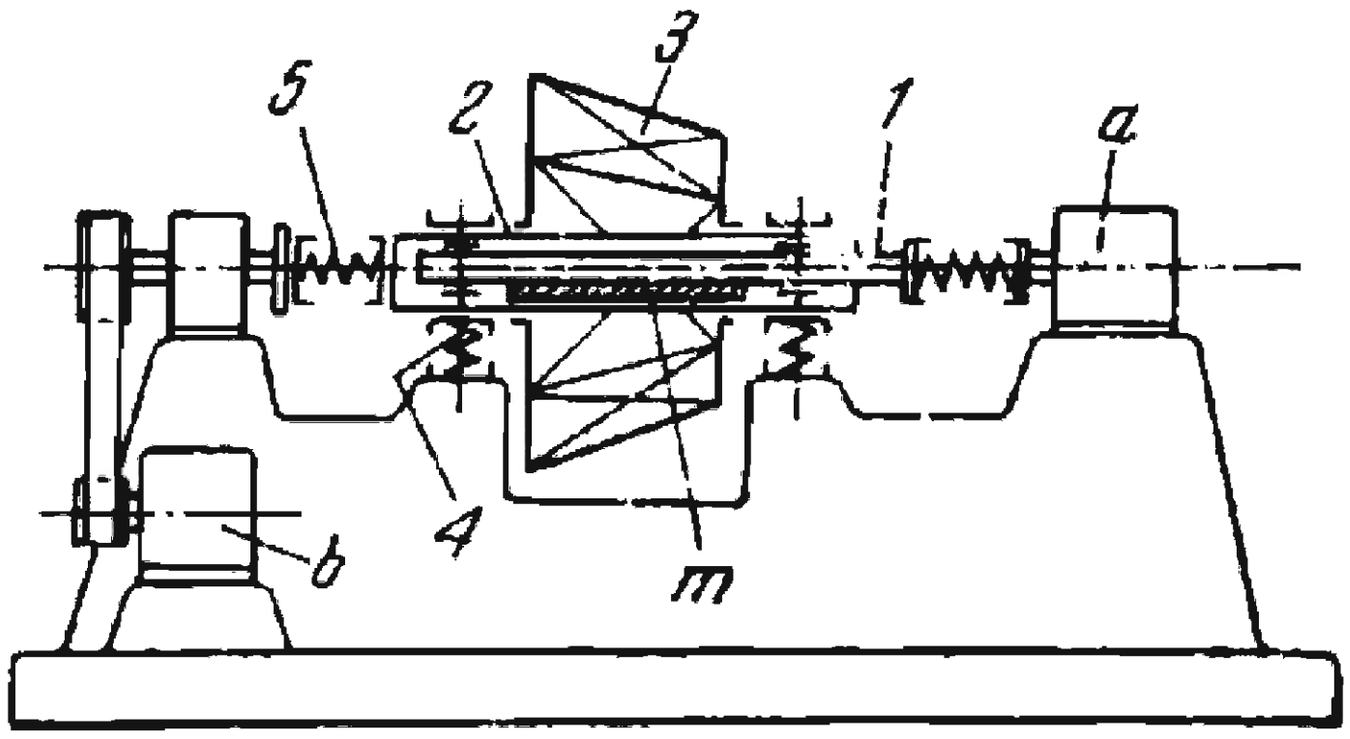
Frame *2* is connected to the fixed base by four identical springs *b* arranged parallel to one another. Housing *a*, carrying disks *1*, is connected to frame *2* by springs *3* and *4*. Attached to the disks are unbalanced masses *m*. When disks *1* rotate, frame *2* has a vibratory motion.

2157	ELASTIC-LINK SIFTER MECHANISM	EL VM



Frame *2* is connected to the fixed base by three springs *a* of equal length and arranged parallel to one another. Attached to disk *1* is unbalanced mass *m*. When disk *1* rotates, frame *2* has a vibratory motion.

2158	CENTRIFUGAL VIBRATING SCREEN MECHANISM	EL VM



The body of screens *3* is mounted on hollow shaft *2* which rests on springs *4* and is connected by spring *5* to the drive powered by electric motor *b*. Shaft *1* runs in bearings mounted inside shaft *2* and carries unbalanced mass *m*. Shaft *1* is driven by electric motor *a*. Shafts *1* and *2* run at different speeds and screens *3* both rotate and have a vibratory motion.

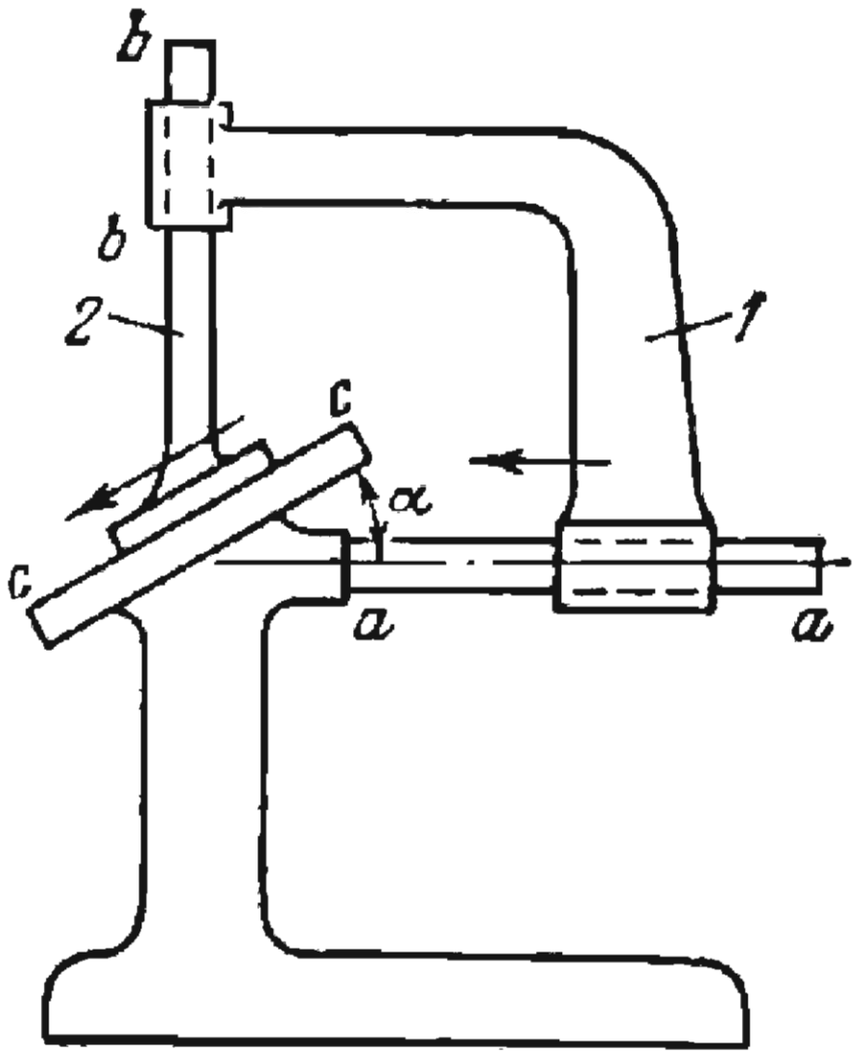
SECTION ELEVEN

Wedge-Lever Mechanisms

WL

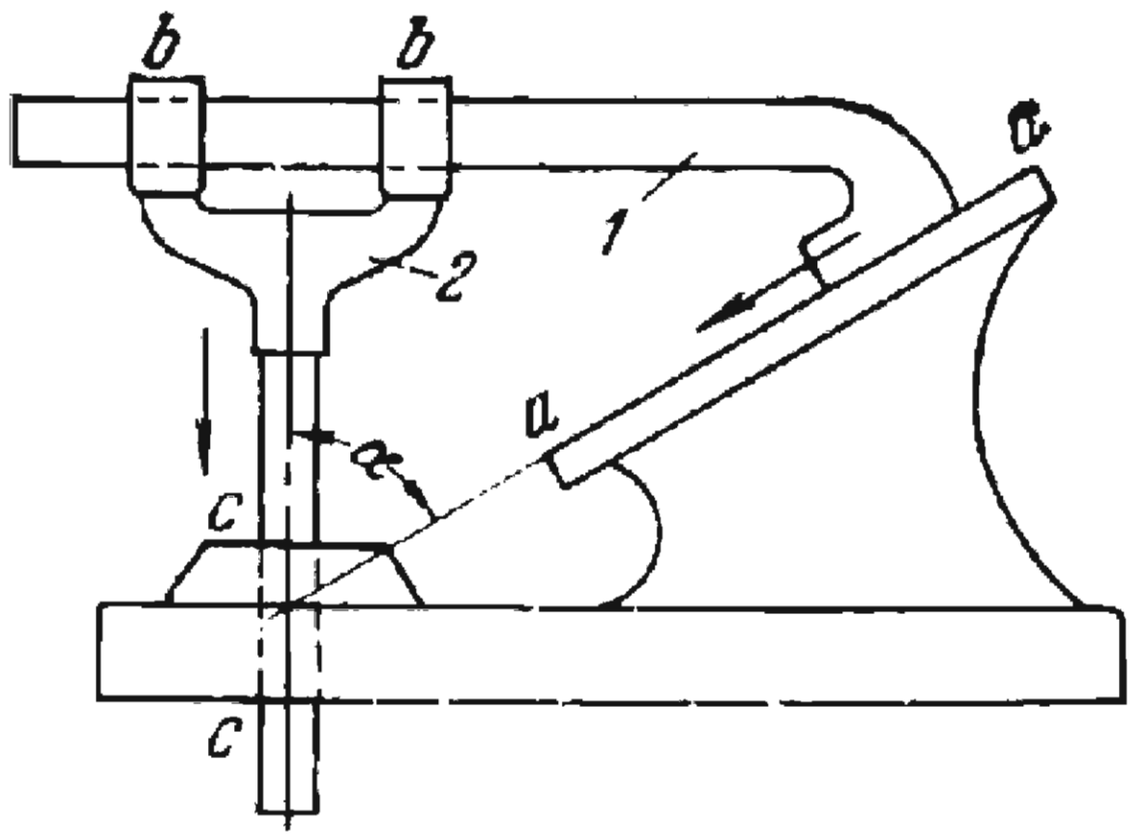
1. General-Purpose Three-Link Mechanisms 3L (2159 through 2174)
2. General-Purpose Four-Link Mechanisms 4L (2175, 2176 and 2177)
3. General-Purpose Six-Link Mechanisms 6L (2178)
4. Dwell Mechanisms D (2179)
5. Stop, Detent and Locking Mechanisms SD (2180 through 2187)
6. Sorting and Feeding Mechanisms SF (2188)
7. Clutch and Coupling Mechanisms C (2189)
8. Mechanisms of Measuring and Testing Devices M (2190, 2191 and 2192)
9. Hammer, Press and Die Mechanisms HP (2193)
10. Brake Mechanisms Br (2194)
11. Gripping, Clamping and Expanding Mechanisms GC (2195 through 2199)
12. Mechanisms of Other Functional Devices FD (2200)

2159	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



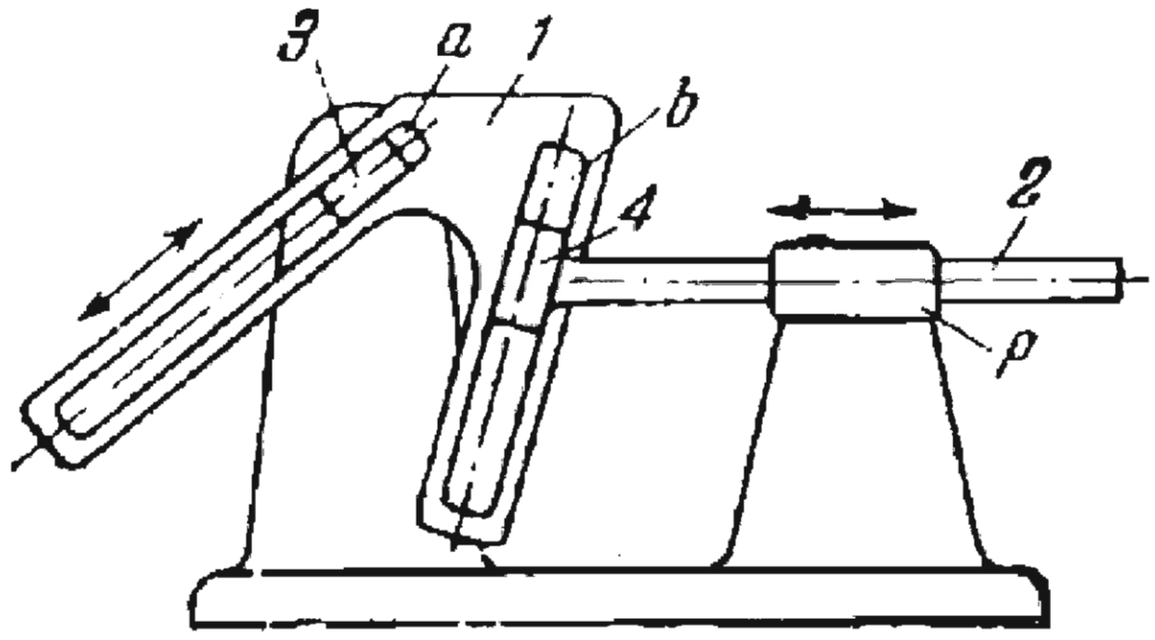
Link *1* has translational motion along fixed guides *a-a* and is connected by sliding pair *b-b* to link *2* which has translational motion along guides *c-c*. The mechanism converts straight translational motion of link *1* along axis *a-a* into straight translational motion of link *2* along axis *c-c* which makes the angle α with axis *a-a*. Displacement s_2 of link *2* is related to displacement s_1 of link *1* by the condition: $s_1 = s_2 \cos \alpha$.

2160	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



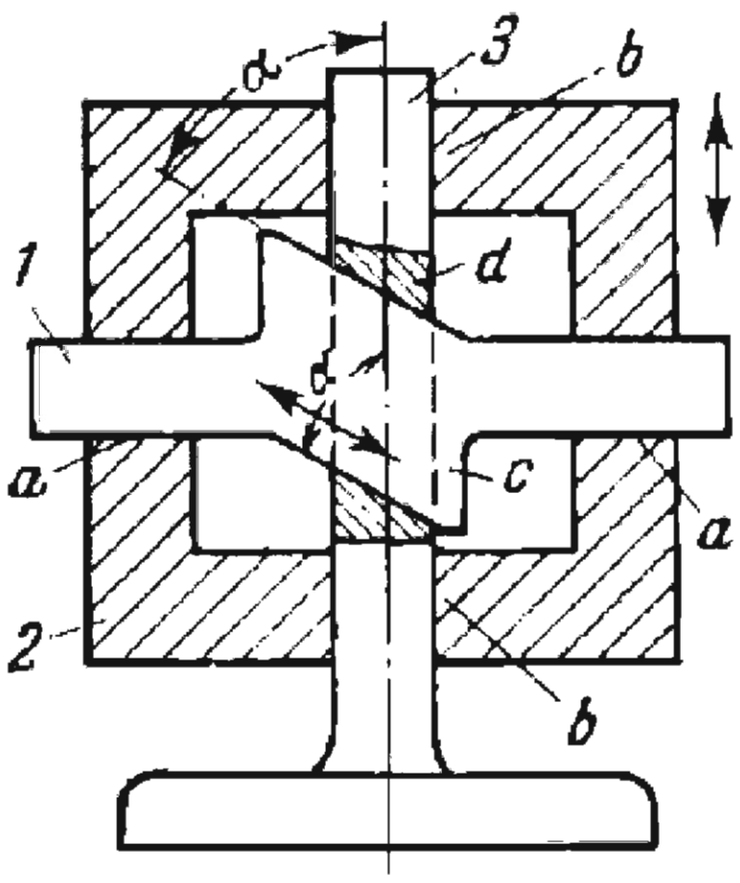
Link *1* has translational motion along fixed guides *a-a* and is connected by sliding pair *b-b* to link *2* which has translational motion in guides *c-c*. The mechanism converts straight translational motion of link *1* along axis *a-a* into straight translational motion of link *2* along axis *c-c* which makes the angle α with axis *a-a*. Displacement s_2 of link *2* is related to displacement s_1 of link *1* by the condition: $s_2 = s_1 \cos \alpha$.

2161	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



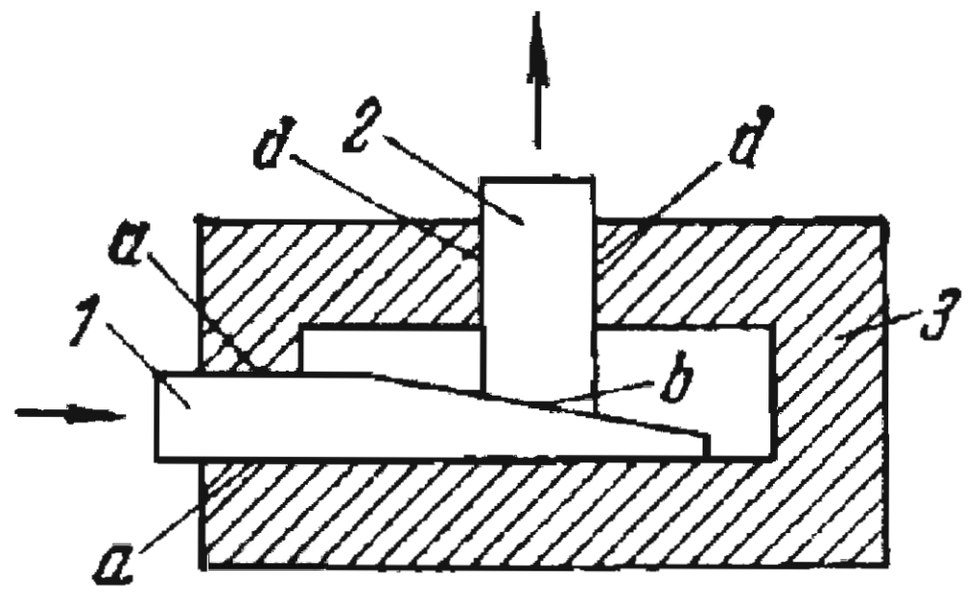
Slider *3* is rigidly attached to the base. Link *1* has slots *a* and *b*. Link *2* is rigidly attached to slider *4*. Link *1* slides with its slots along sliders *3* and *4*. Reciprocating motion of link *1* is converted into reciprocating motion of link *2* in fixed guide *p*.

2162	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



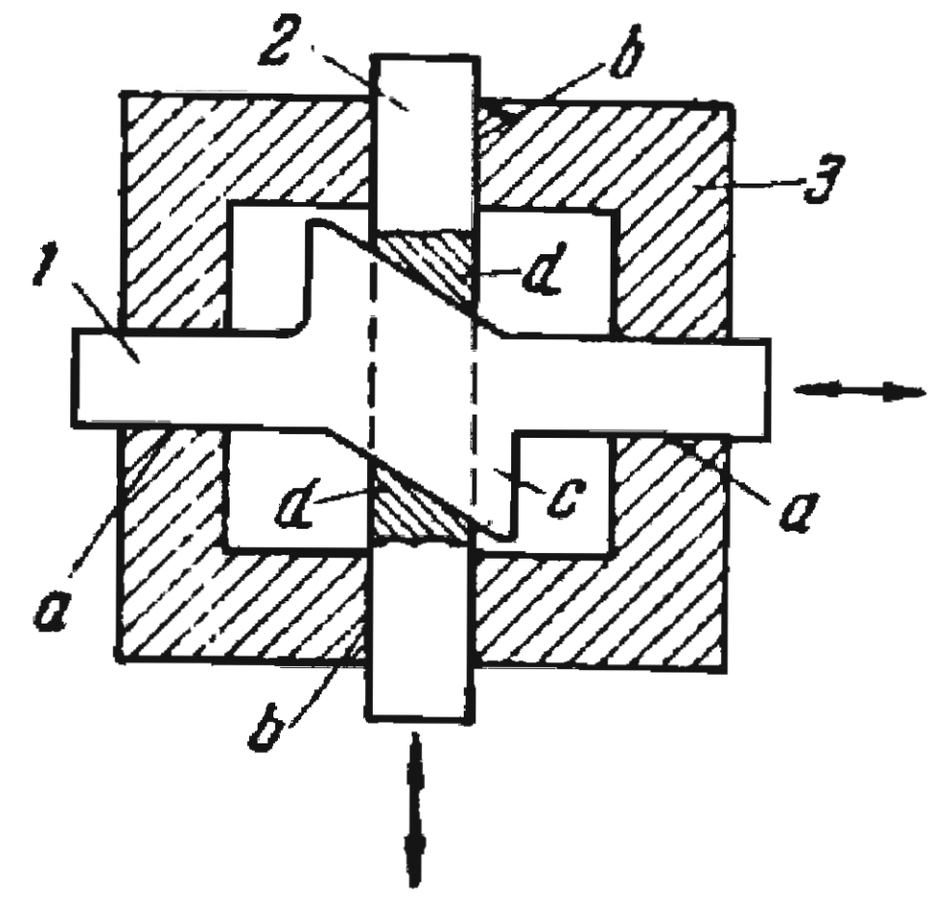
Link *1*, sliding in movable guides *a-a* of link *2*, has rigidly attached block *c* which slides in fixed guide *d*. Link *2* slides in fixed guides *b-b*. Translational motion of link *1* in the direction of the arrow is converted into translational motion of link *2* in a direction making the angle α with the direction of link *1*.

2163	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



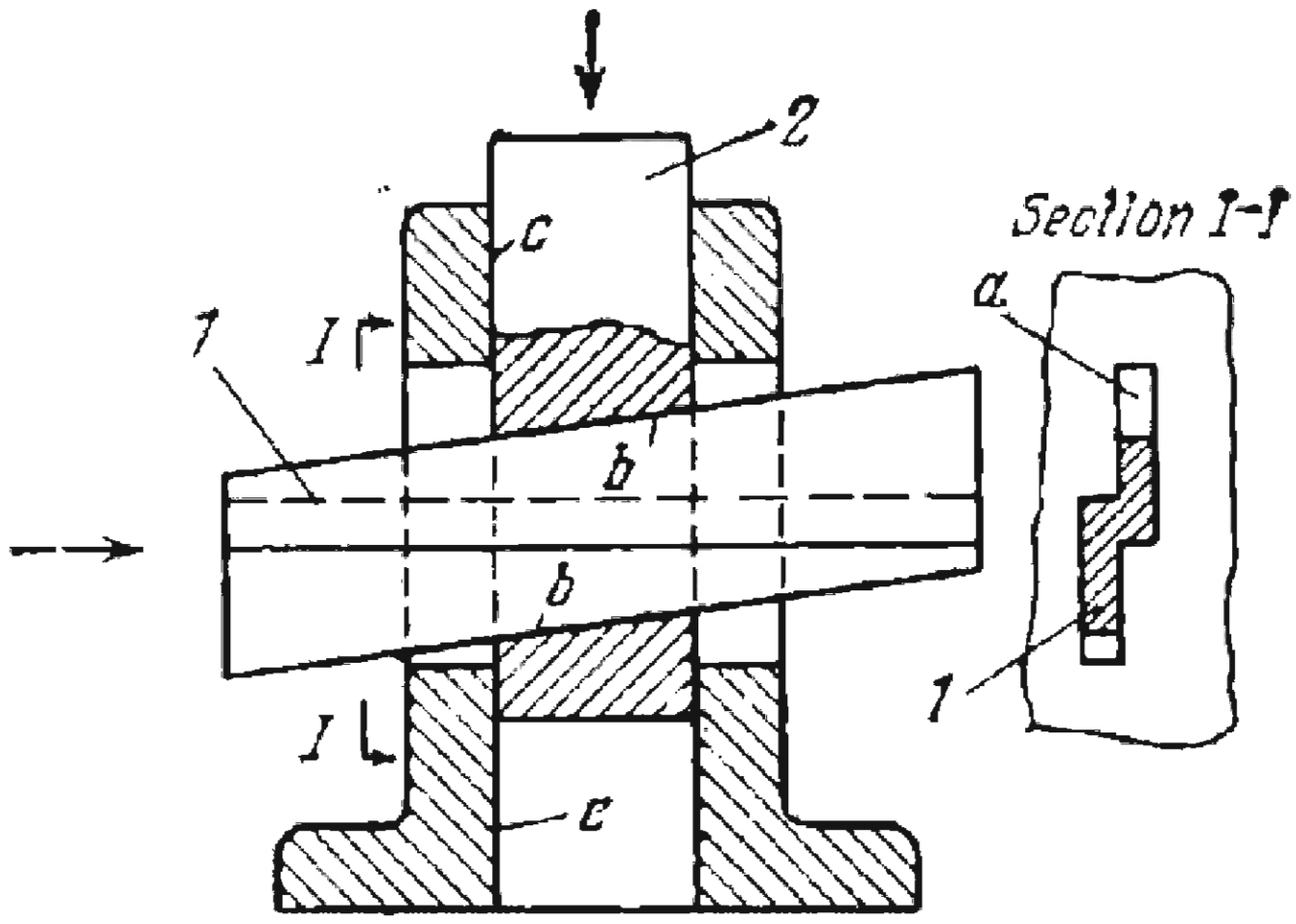
Link *1*, designed as a wedge, slides in fixed guides *a-a* and is connected by sliding pair *b* to link *2* which slides in fixed guides *d-d*. Straight translational motion of link *1* is converted into straight translational motion of link *2* in the perpendicular direction.

2164	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



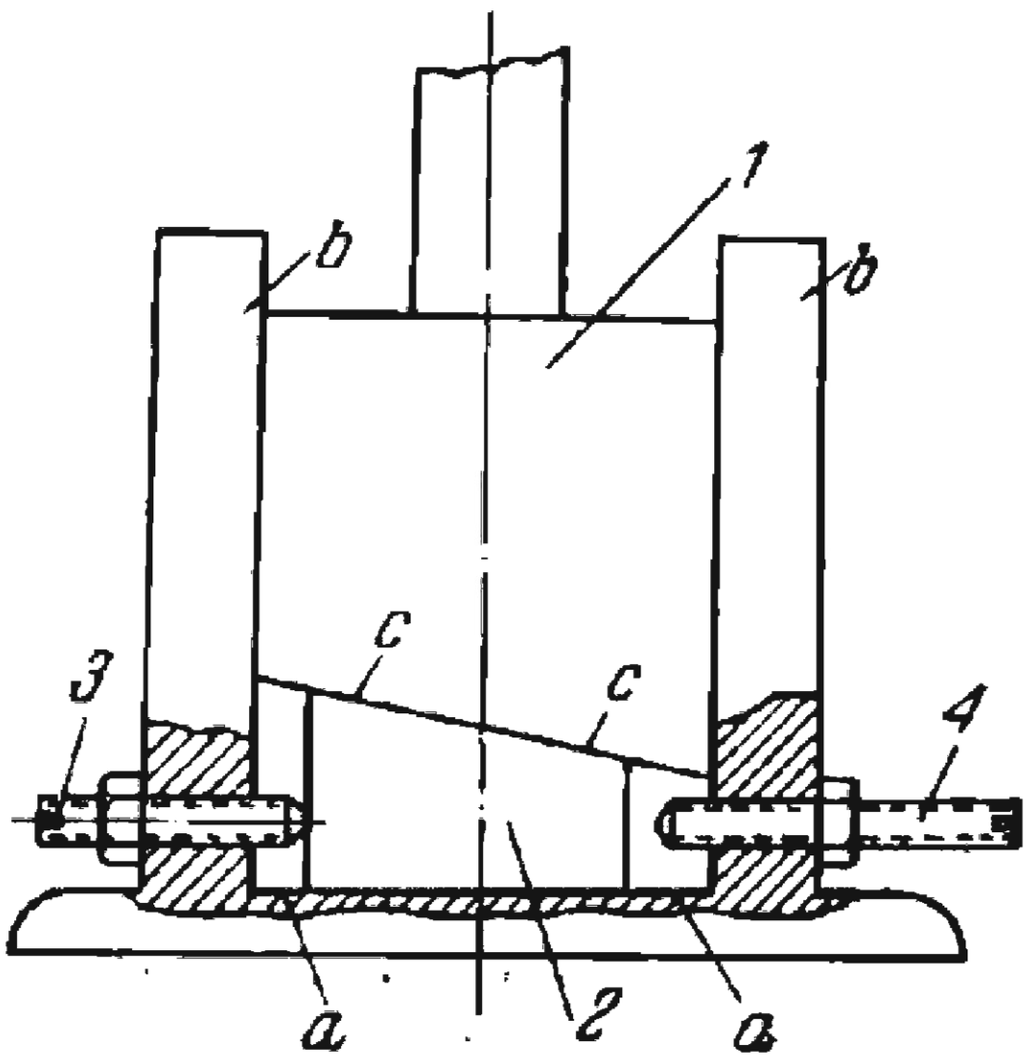
Link *1*, sliding in fixed guides *a-a*, has rigidly attached block *c* which slides in guides *d-d* of link *2*. Link *2* slides in fixed guides *b-b*. Straight translational motion of link *1* is converted into straight translational motion of link *2* in the perpendicular direction.

2165	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



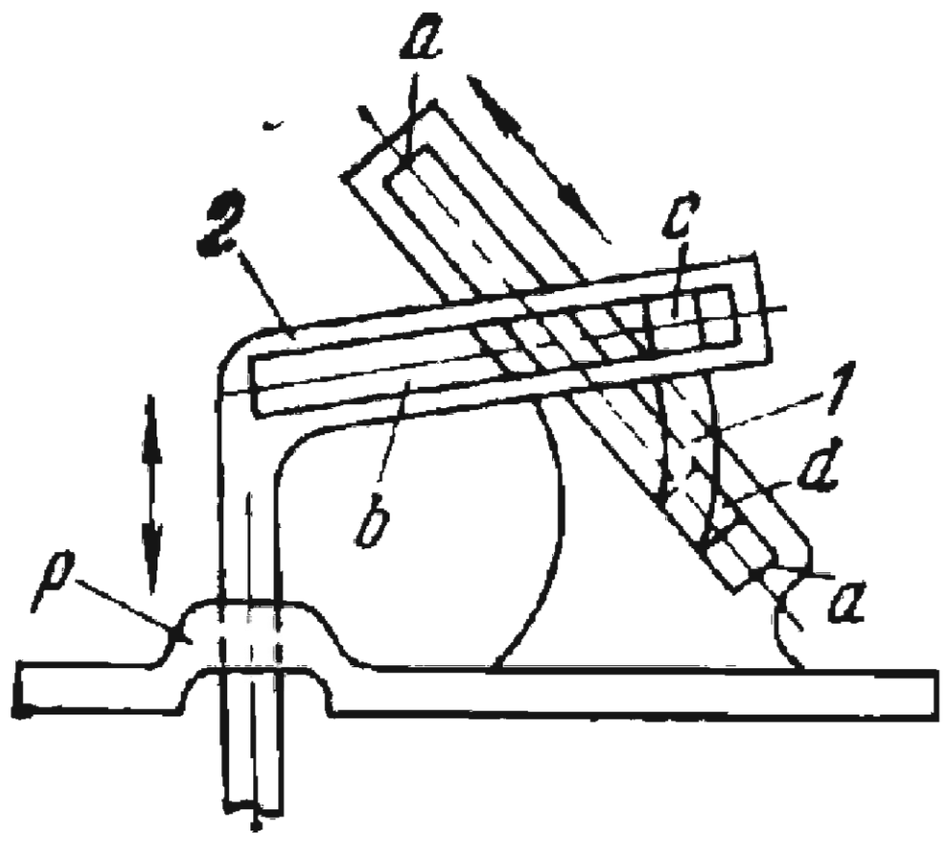
Link *1*, designed as a wedge with two horizontal shoulders (see Section *I-I*), slides in slot *a* of the same shape in the base. Link *1* is connected by sliding pair *b* to link *2* which slides in fixed guides *c-c*. Straight (horizontal) translational motion of link *1* is converted into straight (vertical) translational motion of link *2* (i.e. in the perpendicular direction).

2166	THREE-BAR WEDGE-TYPE MECHANISM WITH A LIMITED STROKE OF THE DRIVEN LINK	WL 3L



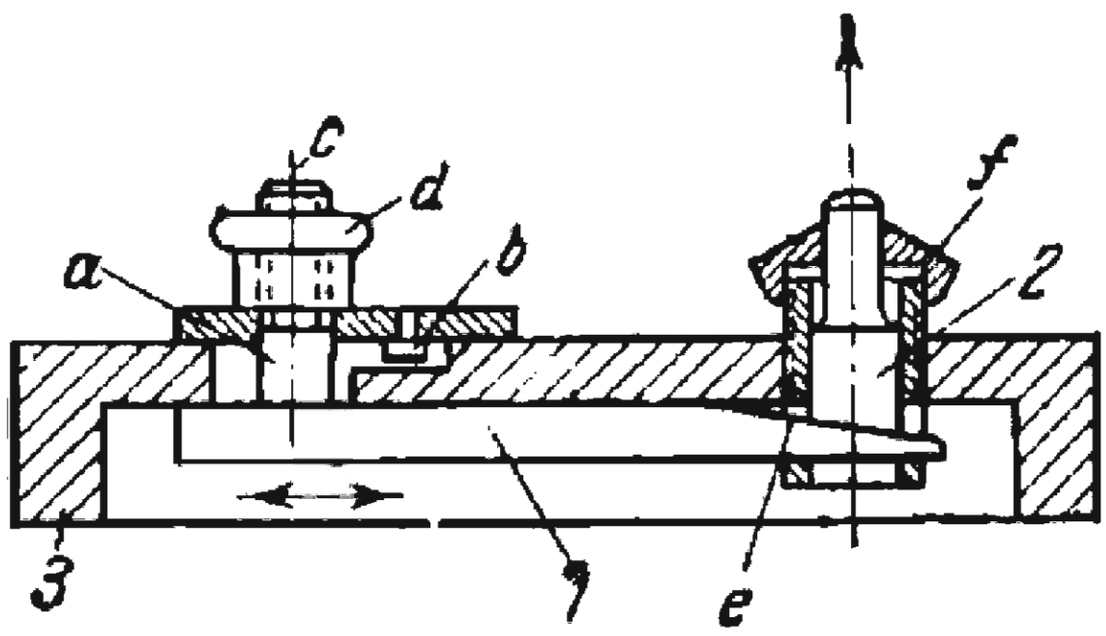
Link *2*, designed as a wedges, slides along fixed guides *a-a* and is connected by sliding pair *c-c* to link *1* which slides along fixed guides *b-b*. Link *1* moves up or down when link *2* is moved to the right or left. Set screws *3* and *4*, locked by nuts, limit the stroke of wedge *2* and thereby also limit the stroke of link *1*.

2167	THREE-BAR WEDGE-TYPE MECHANISM	WL 3L



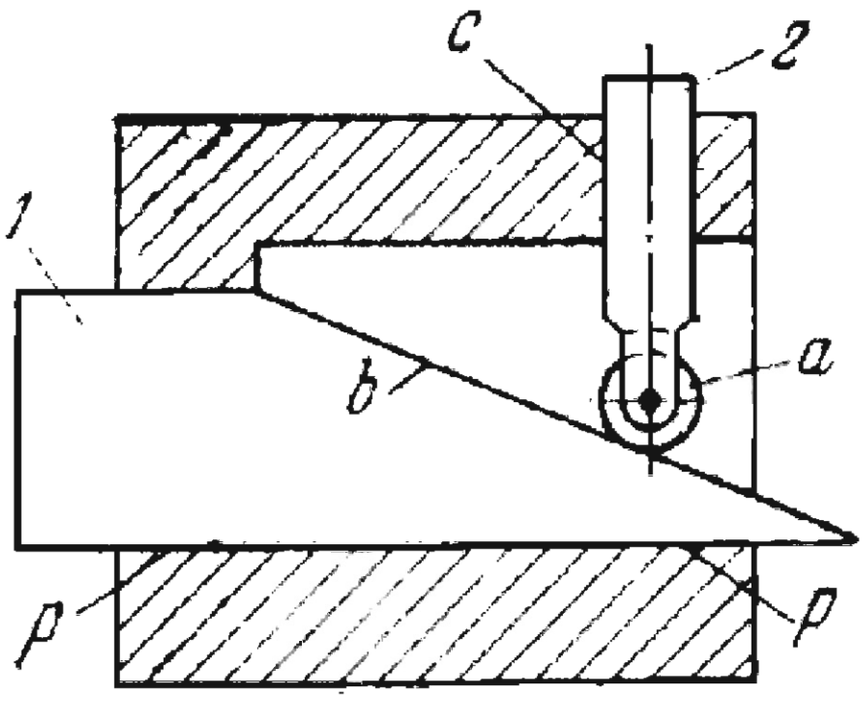
Link *2* slides in fixed guide *p* and has slot *b* along which slider *c* of link *1* moves. Slider *d* of link *1* moves along fixed guides *a-a*. Reciprocating motion of double slider *1* along guides *a-a* is converted into reciprocating motion of link *2* in guide *p*.

2168	THREE-BAR WEDGE-TYPE MECHANISM WITH STOPS	WL 3L



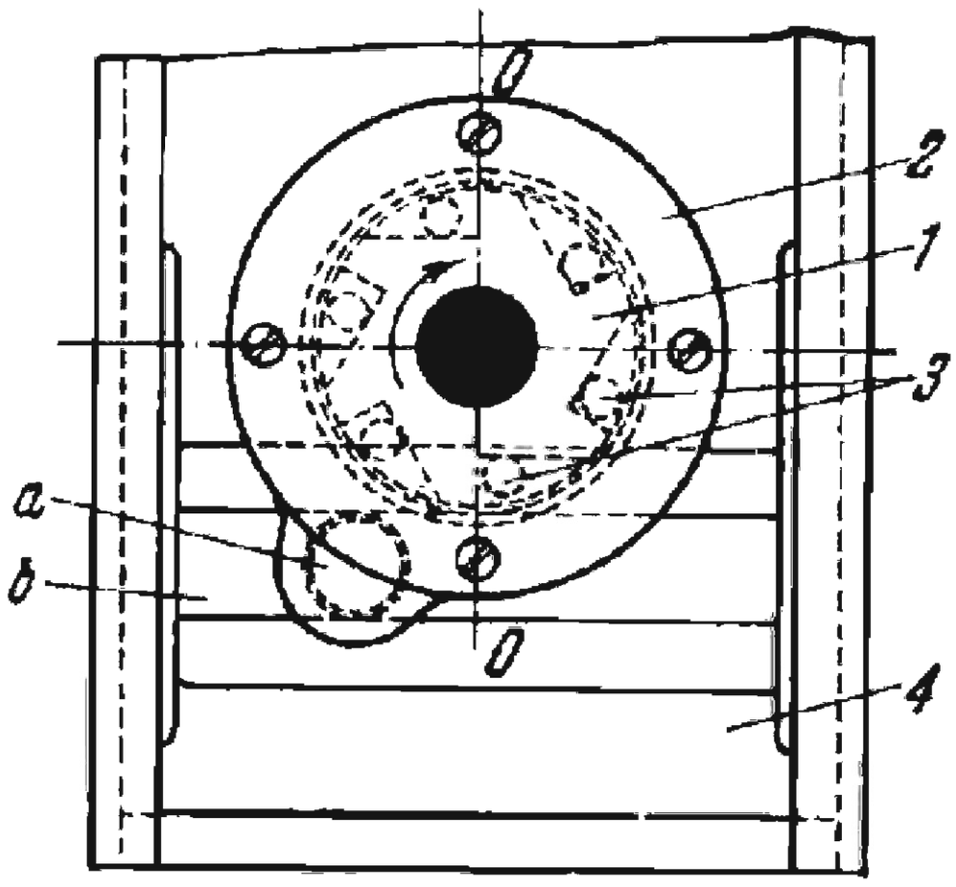
Rigidly attached to link *1* is pin *a*, screw *c* and special nut *d*. Using nut *d*, link *1* is held with its horizontal surface tight against fixed link *3* and can be moved only horizontally. Screw *b* is a stop restricting the motion of link *1*. Link *1* has a tapered surface *e* sliding along the inclined surface of link *2* which, in turn, slides in fixed guide *f*. When link *1* is displaced horizontally, link *2* moves vertically.

2169	WEDGE-TYPE MECHANISM WITH A ROLLER	WL 3L



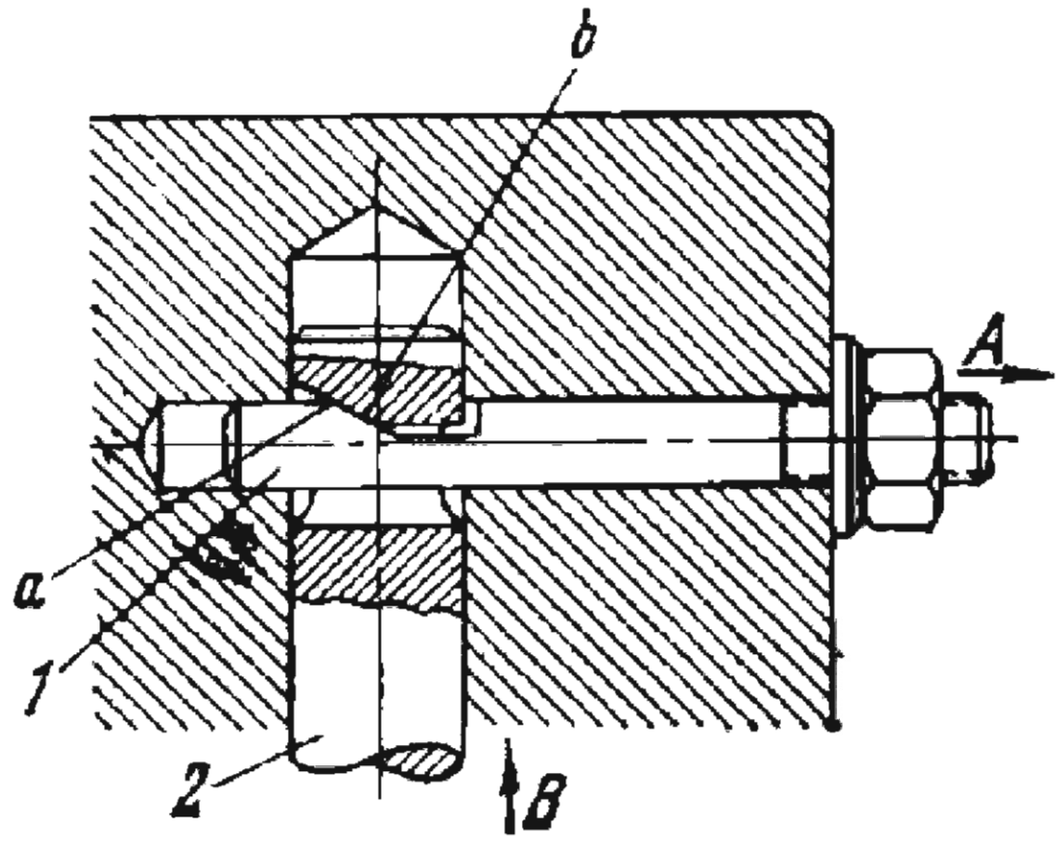
Link *1* slides along fixed guides *p-p* and its tapered surface *b* acts on roller *a* of link *2* which slides in fixed guide *c*. The use of roller *a* changes the sliding friction between links *1* and *2* to rolling friction.

2170	WEDGE-LEVER OVERRUNNING MECHANISM	WL 3L



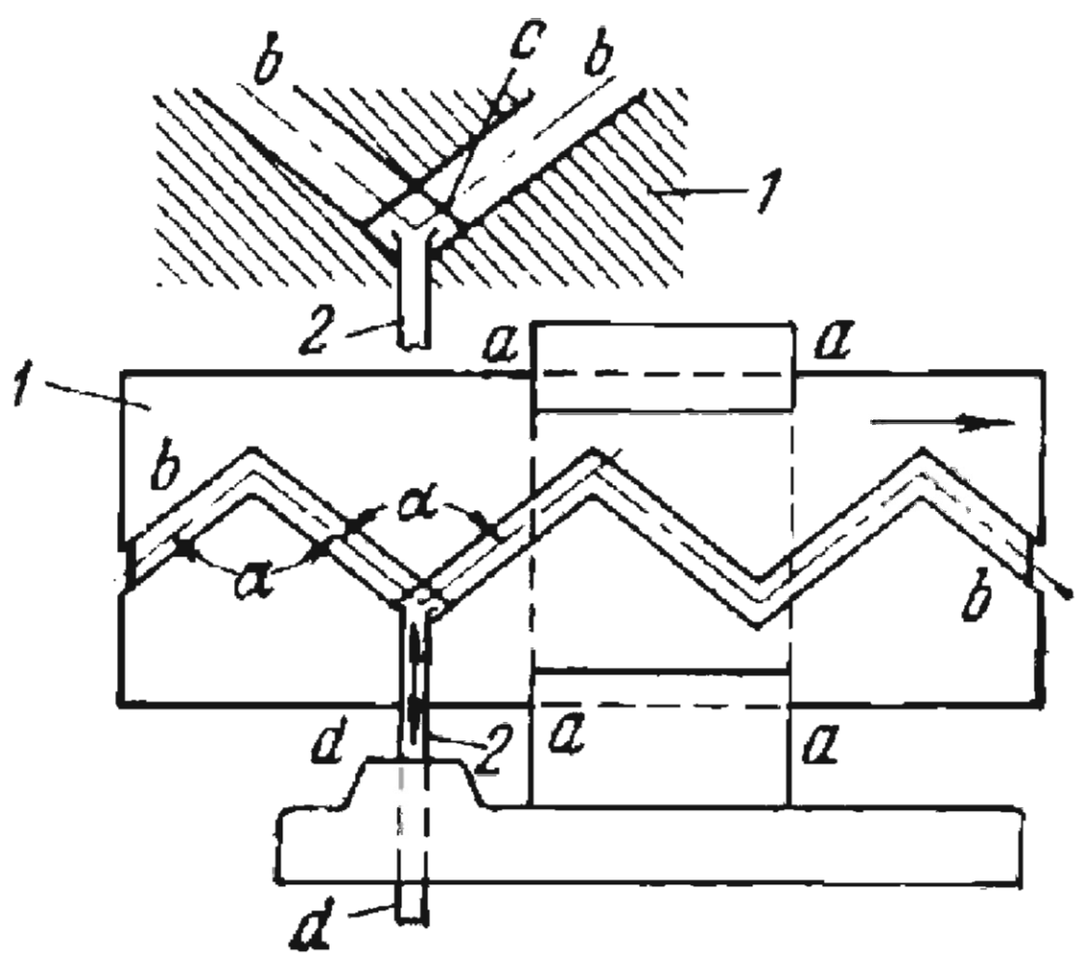
When link *1* rotates clockwise, housing *2* is rotated in the same direction by the action of jammed rollers *3* if roll *a*, sliding along slot *b* of slider *4*, is in a position to the left of line *0-0*. In this case slider *4* moves upward. As soon as the slider passes its extreme upward position and the centre of roll *a* is to the right of line *0-0*, housing *2*, subject to the weight of slider *4*, begins to rotate independently of link *1* because rollers *3* are released.

2171	WEDGE-TYPE TWO-ROD MECHANISM	WL 31



Rod *1* slides along a horizontal axis and has wedge surface *a* which contacts surface *b* of rod *2*, sliding along a vertical axis. Displacement of rod *1* to the right (arrow *A*) leads to displacement of rod *2* upward (arrow *B*)

2172	WEDGE-TYPE SLOTTED MECHANISM	WL 3L

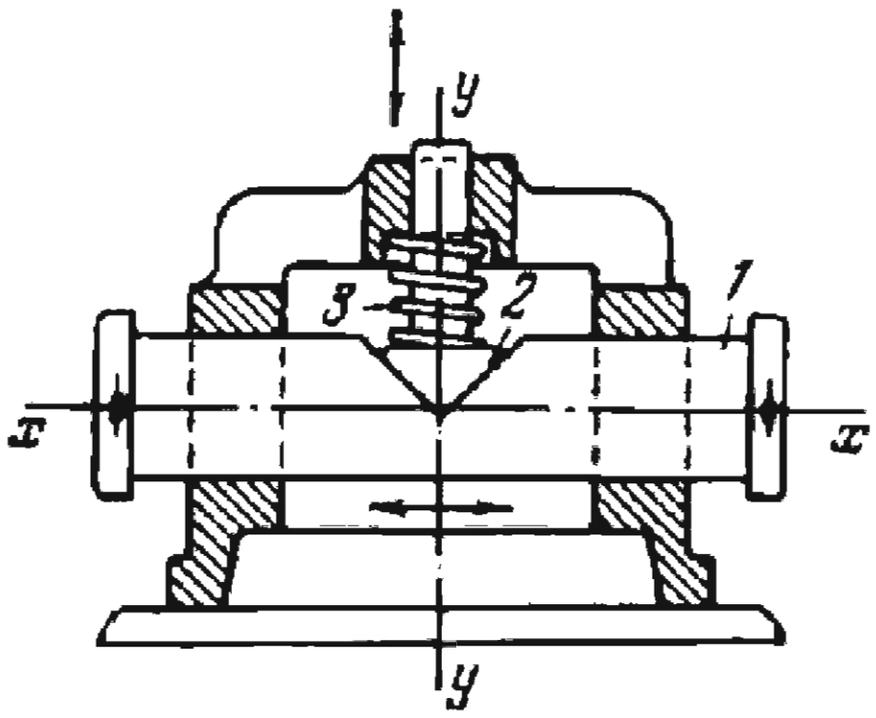


Link *1* has straight translational motion along fixed guides *a-a*. This link has a zigzag slot *b-b*. Link *2*, ending in a rhombus-shaped head *c* which slides along slot *b-b*, has straight translational motion in fixed guides *d-d*. The axes of guides *a-a* and *d-d* are perpendicular to each other. The mechanism converts straight translational motion of link *1* in one direction into straight reciprocating motion of link *2*. Displacement s_1 of link *1* is related to displacement s_2 of link *2* by the equation

$$s_1 = s_2 \tan \frac{\alpha}{2}.$$

2173 WEDGE-TYPE CENTERING MECHANISM

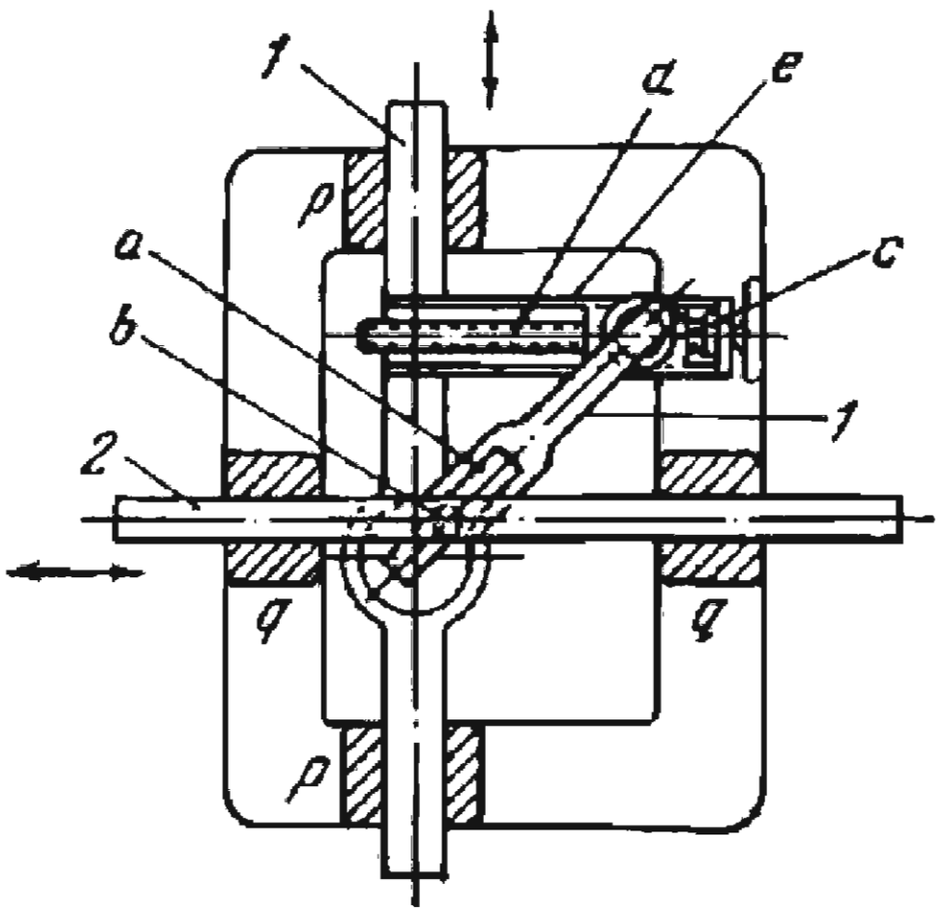
WL
3L



Slider *1* moves in fixed guides along axis *x-x*. Wedge link *2* slides along axis *y-y*. When slider *1* is deviated from its central position, wedge *2*, subject to the action of spring *3*, returns slider *1* to its initial central position.

2174 WEDGE-TYPE MECHANISM WITH DRIVEN LINK STROKE ADJUSTMENT

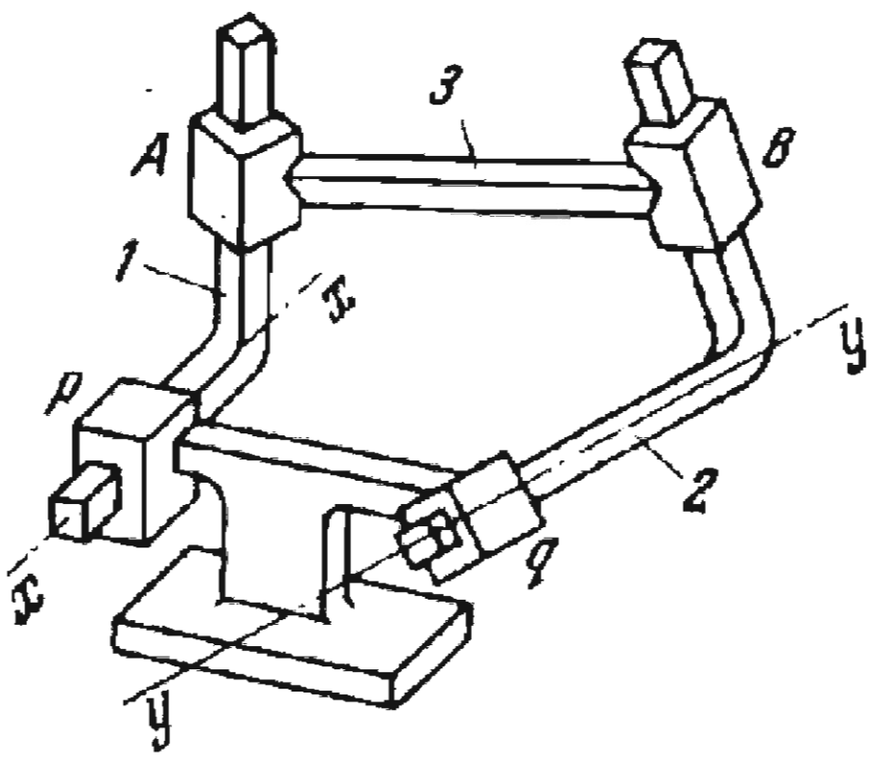
WL
3L



Link *1* slides in fixed guides *p-p* and has slot *a* whose position can be varied by means of screw *d* and nut *c* which is designed as a slider moving in guides *e* of link *1*. Link *2* slides in fixed guides *q-q* and has pin *b* sliding along slot *a*. When link *1* moves vertically, link *2* is moved horizontally (i.e. in the perpendicular direction). The displacement of link *2*, to a given displacement of link *1*, can be varied by changing the angle of inclination of slot *a*, using screw *d* and nut *c* for this purpose.

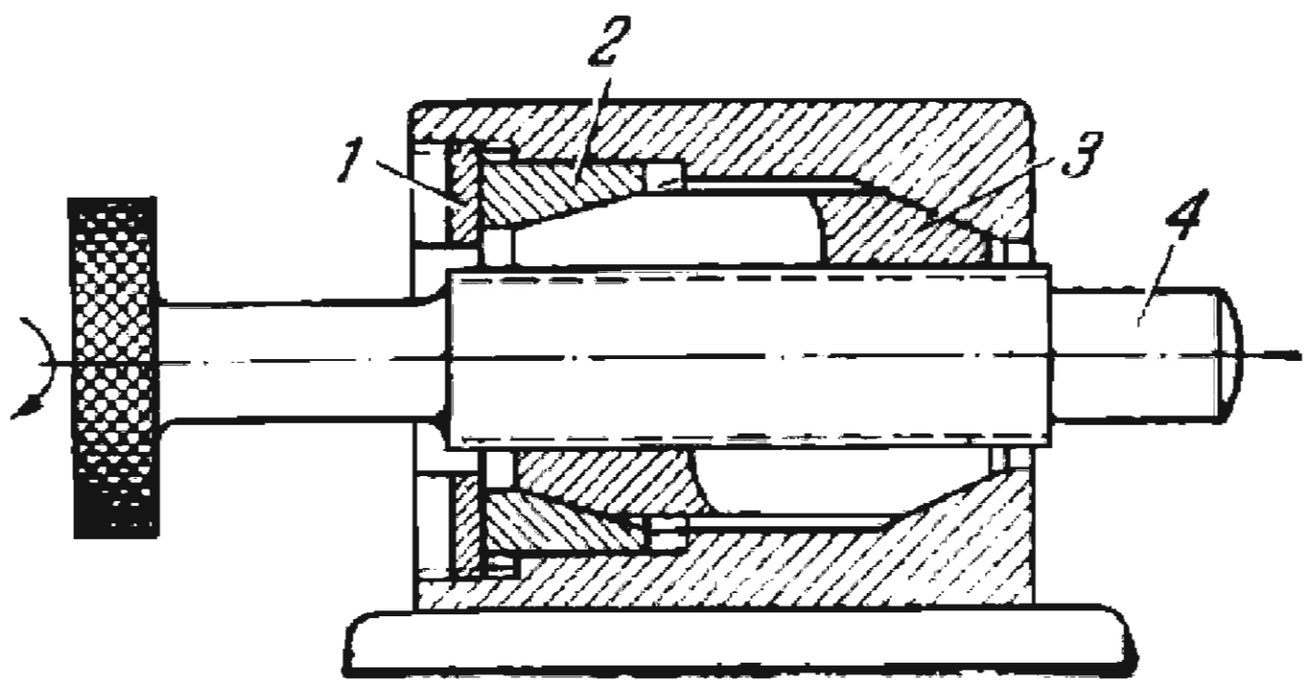
2. GENERAL-PURPOSE FOUR-LINK MECHANISMS (2175, 2176 and 2177)

2175	FOUR-BAR WEDGE-TYPE SPATIAL MECHANISM	WL 4L



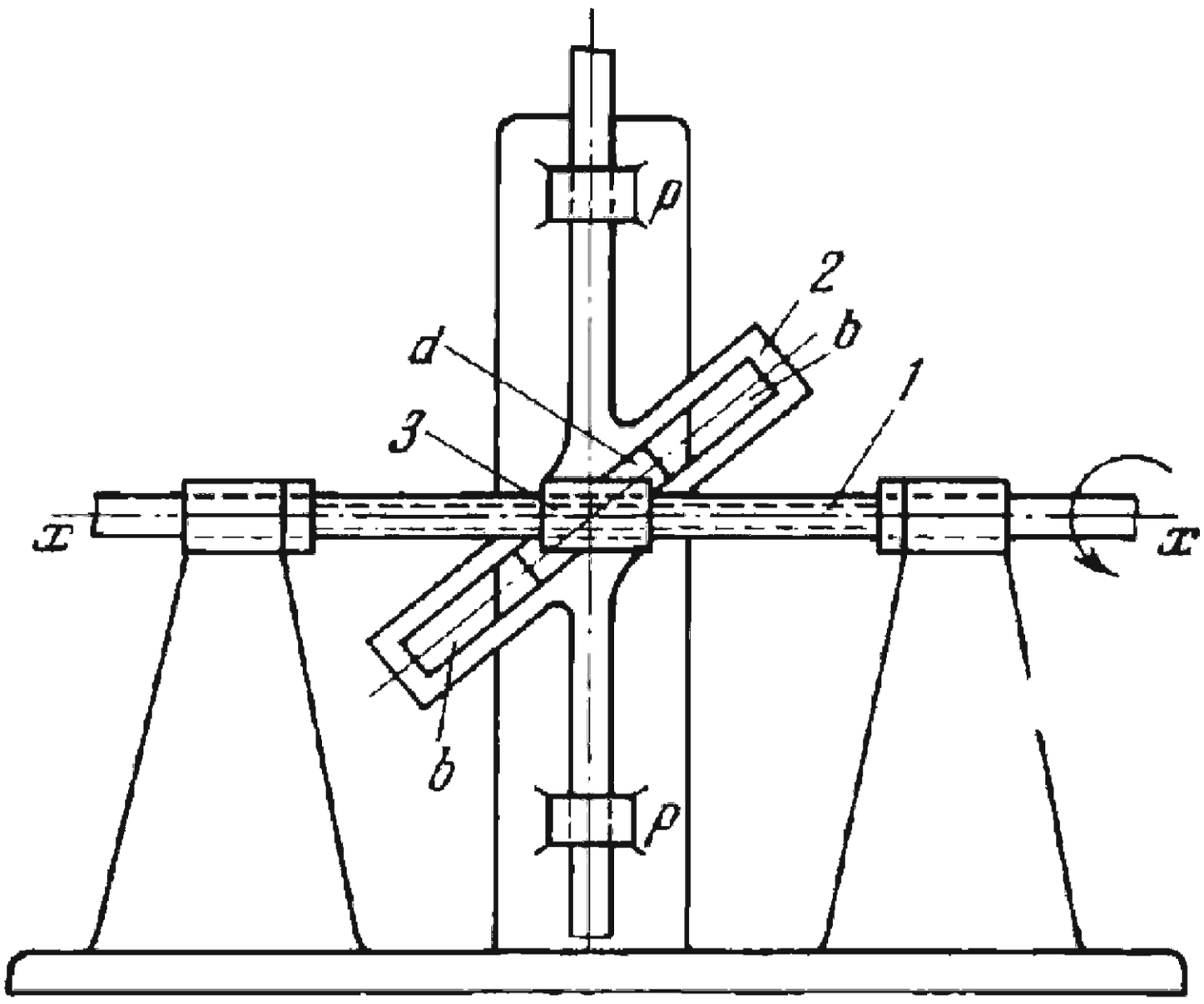
Link *1* slides along axis *x-x* in fixed guide *p* and is connected by sliding pair *A* to link *3*. Link *2* is connected by sliding pair *B* to link *3* and slides along axis *y-y* in fixed guide *q*. When link *1* has straight translational motion along axis *x-x*, link *2* has straight translational motion along axis *y-y*. Axes *x-x* and *y-y* intersect in space.

2176	SCREW-WEDGE BACKLASH ELIMINATING DEVICE	WL 4L



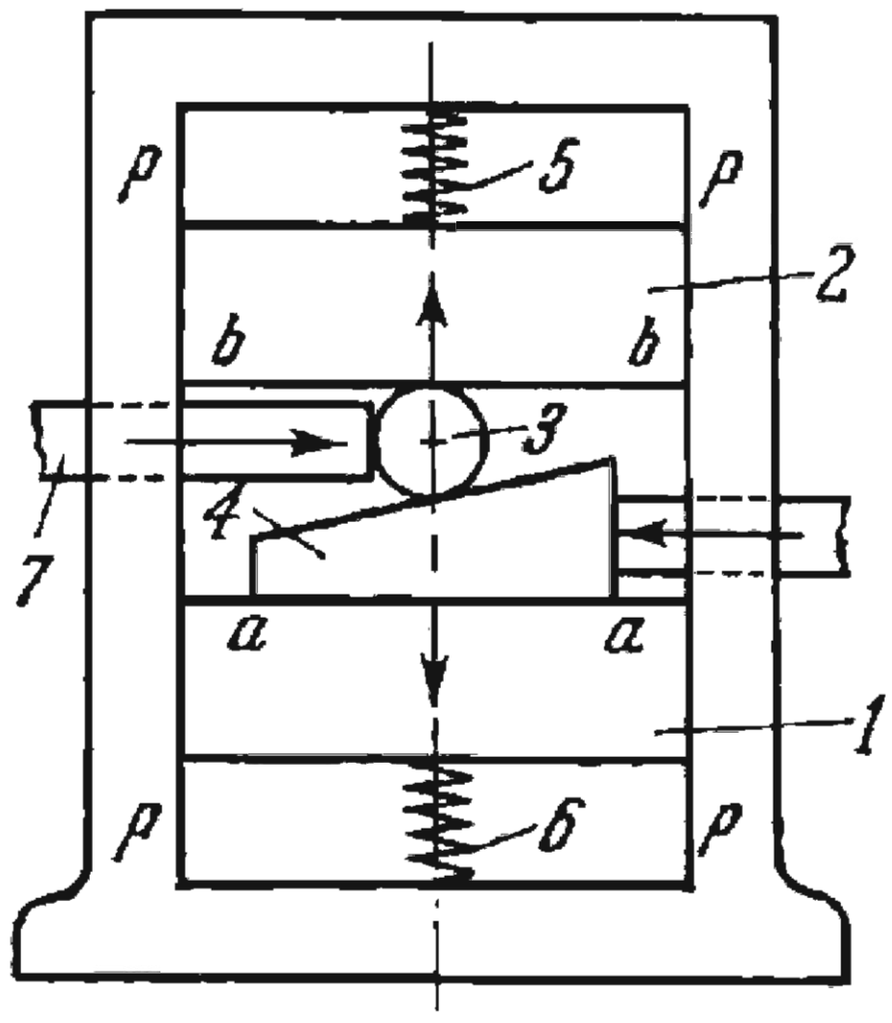
Link *1* is connected by a screw pair to the fixed base. Screw *4* is connected by a screw pair to split nut *3* which has tapered external surfaces and slits cut from both ends. When link *1* is screwed in, tapered sleeve *2* compresses split nut *3*, thereby reducing the clearance between screw *4* and nut *3*, and eliminating backlash between these links.

2177	SCREW-WEDGE TRANSLATIONAL SLOTTED-LINK MECHANISM	WL 4L



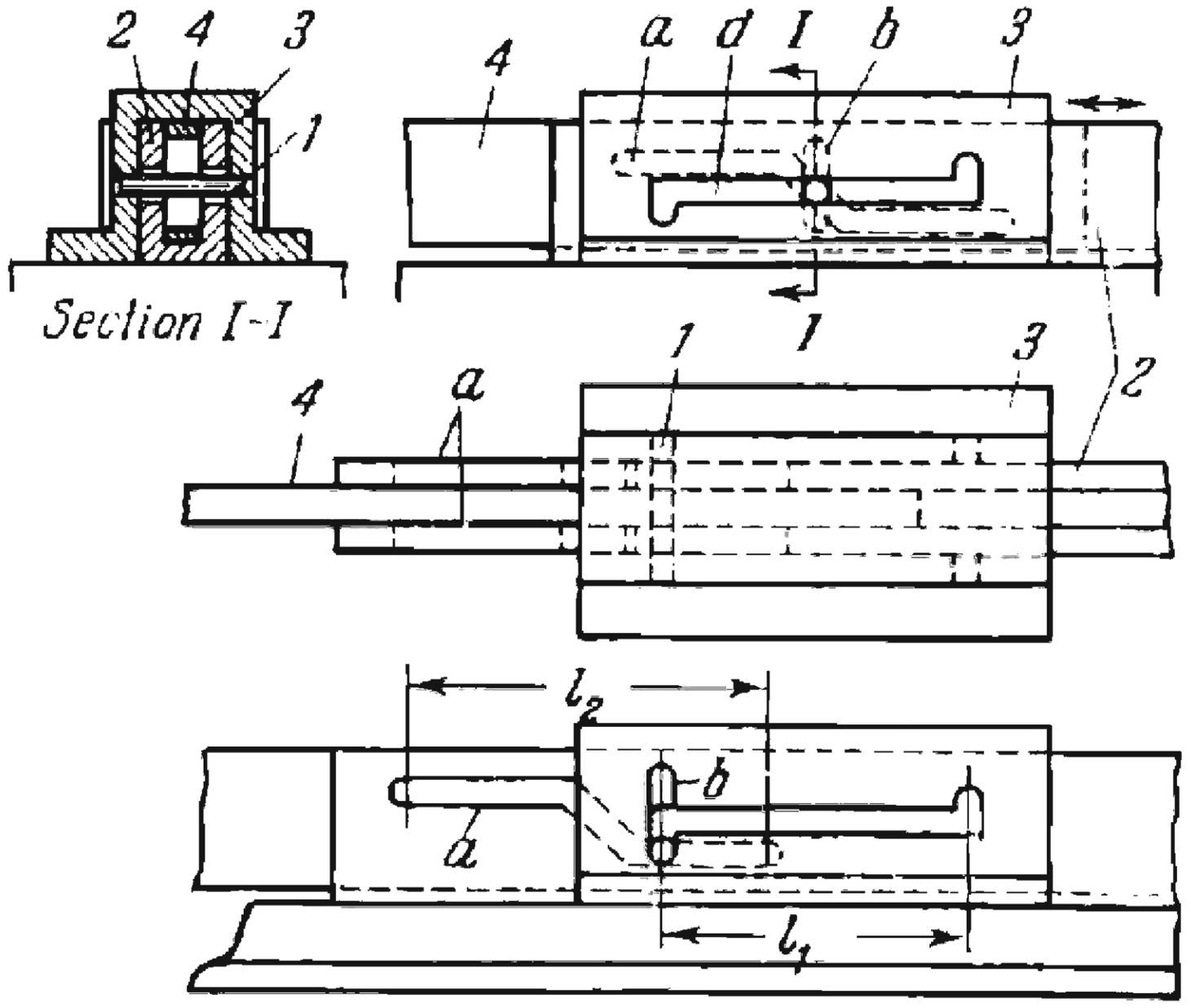
Link *1* turns about fixed axis *x*-*x* and is connected by a screw pair to link *3*. Rigidly attached to link *3* is slider *d* which moves along slot *b*-*b* of link *2*. Slotted link *2* slides in fixed guides *p*-*p*. When link *1* is rotated, slotted link *2* has straight translational motion in guides *p*-*p*.

2178	SIX-BAR WEDGE-TYPE MECHANISM	WL 6L



Sliders *1* and *2* move along fixed guides *p-p* and are spring-loaded by springs *6* and *5*. Wedge *4* slides along plane *a-a* of slider *1* and its tapered surface contacts ball or roller *3* which, in turn, is in contact with plane *b-b* of slider *2*. When links *4* and *7* move in the directions shown, sliders *1* and *2* are spread apart and move vertically in guides *p-p*.

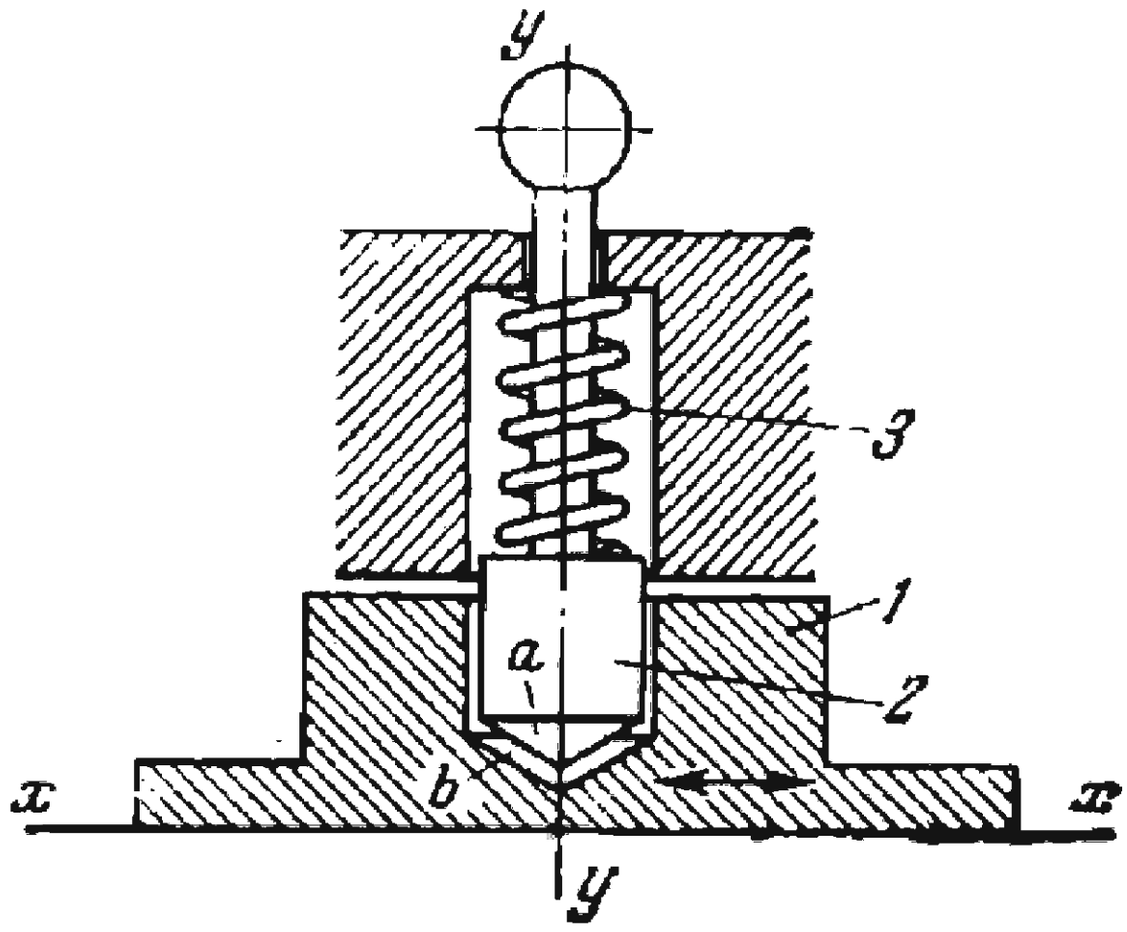
2179	WEDGE-TYPE INTERMITTENT MOTION MECHANISM	WL D



Pin *1* simultaneously enters three slots, *a*, *d* and *b*, milled in links *2*, *3* and *4*, respectively. When link *2* is displaced, motion is transmitted by pin *1* to link *4*. Link *4* moves as long as pin *1* is in the horizontal portion of slot *d* of fixed link *3*. As soon as pin *1* enters the upper or lower vertical portion of slot *d*, link *4* stops. Link *2* continues to move until pin *1* reaches its extreme position in slot *a*. When link *2* is moved in the reverse direction, link *4* begins to move when pin *1* is lifted by slot *a* to the horizontal portion of slot *d*. The length l_2 of slot *a* depends upon the distance l_1 between the vertical portions of slot *d*.

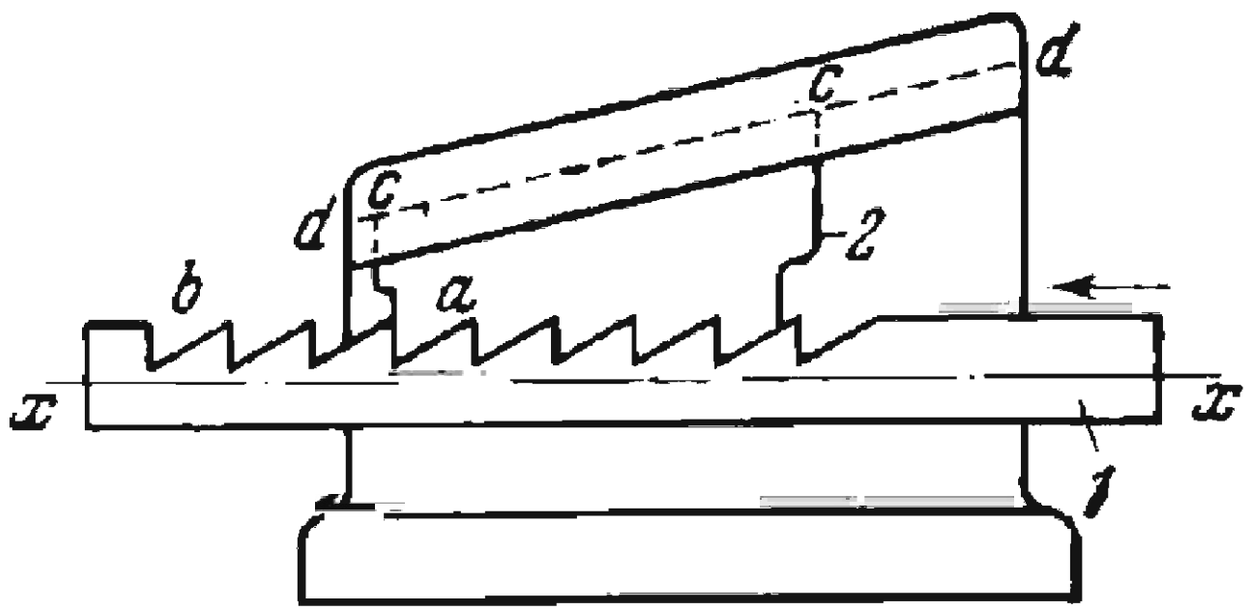
5. STOP, DETENT AND LOCKING MECHANISMS
(2180 through 2187)

2180	WEDGE-TYPE STOP MECHANISM	WL SD



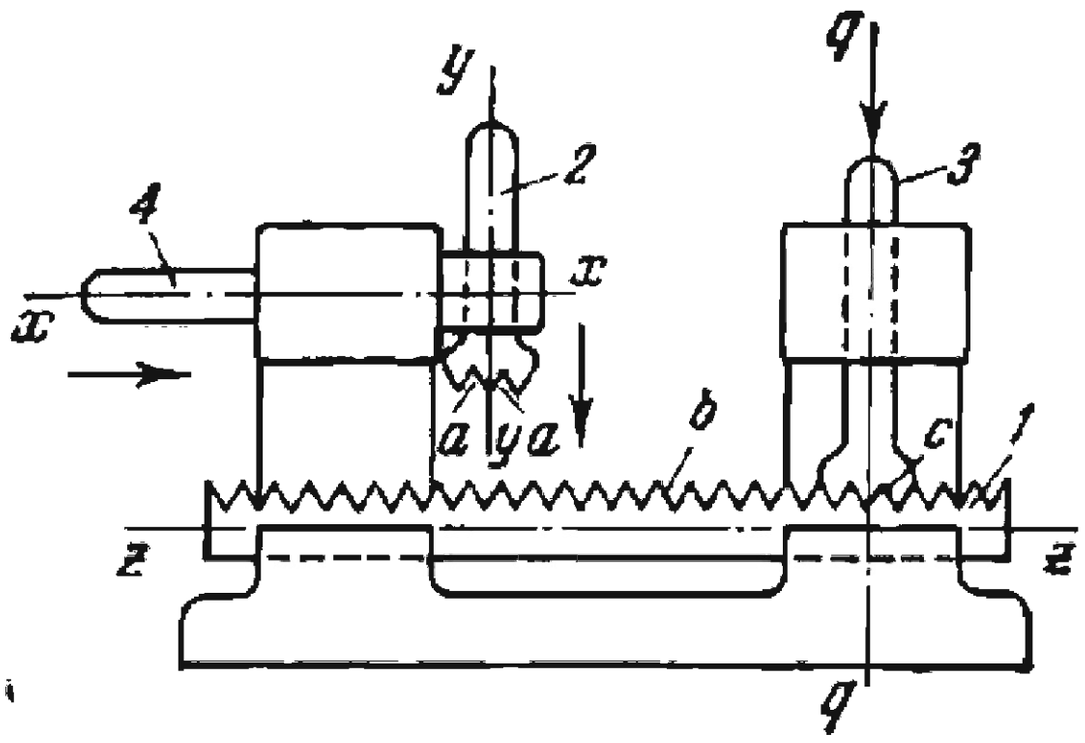
Link *1* has straight translational motion along axis *x-x*. Link *2* has translational motion along axis *y-y* and has conical tip *a*. Part *1* is stopped in a definitely located position when the tip of link *2* enters conical recess *b* in link *1*. Spring *3* holds the device in the stopped position.

2181	WEDGE-TYPE STOP MECHANISM	WL SD



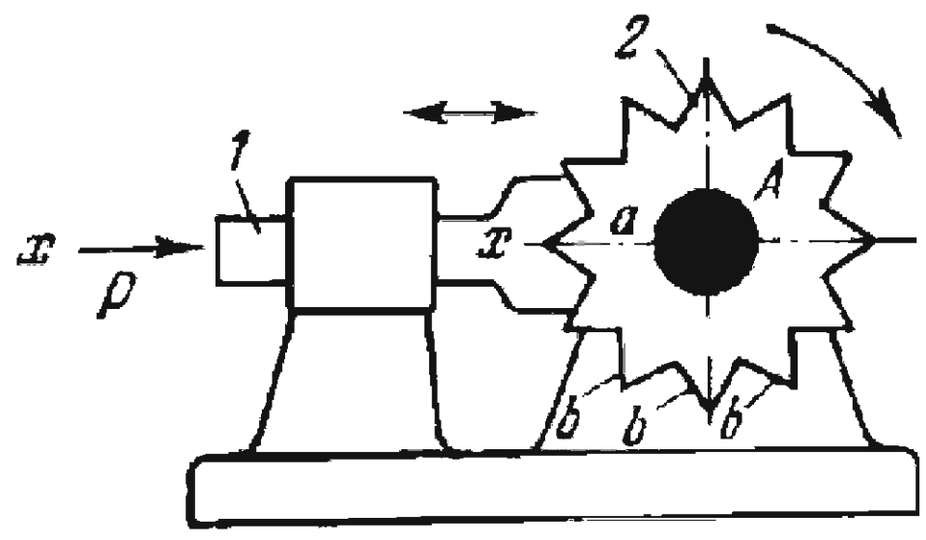
Rack *1* moves in a straight line along axis *x-x* and has wedge-shaped tooth spaces *b* which engage the wedge-shaped teeth of link *2*. Link *2* has inclined edge *c-c*. Rack *1* is in constant engagement with link *2* and its motion is stopped when the rack and link move to the left and reach the position shown where inclined edge *c-c* of link *2* comes into contact with inclined recess *d-d* of the base. Teeth *a* and tooth spaces *b* are right triangles.

2182	WEDGE-TYPE STOP MECHANISM	WL SD



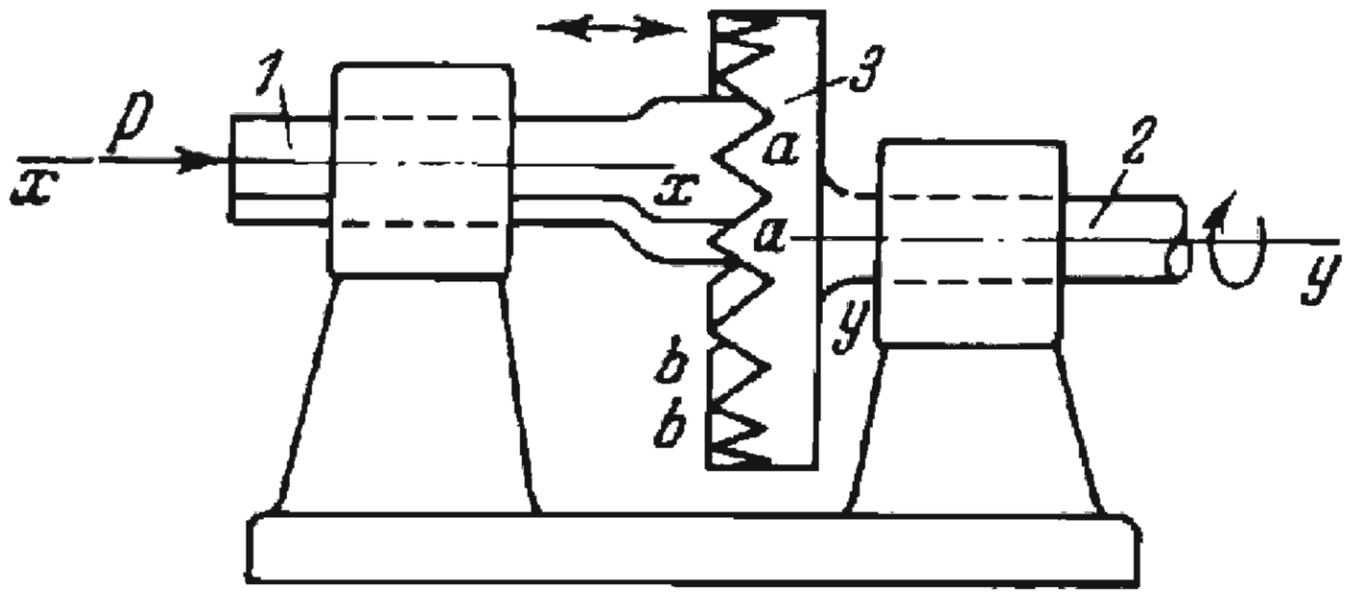
Link *4* slides along axis *x-x* in a fixed guide. Link *2* slides along axis *y-y* and has, at its end, wedge-shaped tooth spaces *a-a*. Rack *1* slides along axis *z-z* and has wedge-shaped teeth *b*. Link *3* slides along axis *q-q* and has wedge-shaped tooth spaces *c*. Rack *1* is traversed by advancing link *2* into engagement with teeth *b* and retracting link *3* out of engagement with teeth *b*. Then link *4* can be pushed to the right with rack *1*.

2183	FORCE-ENGAGED WEDGE-TYPE STOP MECHANISM	WL SD



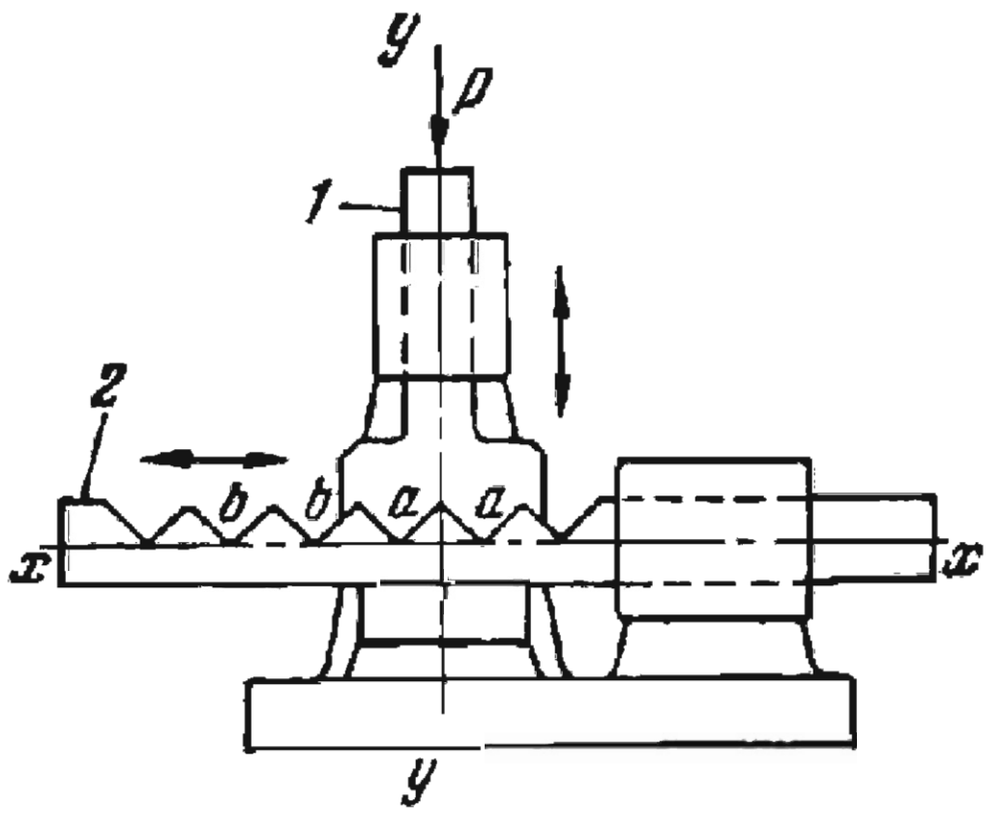
Link *1* slides along axis *x-x* in fixed guides and has a wedge-shaped recess *a*. Link *2* rotates about axis *A* and has wedge-shaped teeth *b*. Force *P* presses link *1* against the teeth of link *2*, locking it against rotation in either direction.

2184	FORCE-ENGAGED WEDGE-TYPE SPATIAL STOP MECHANISM	WL SD



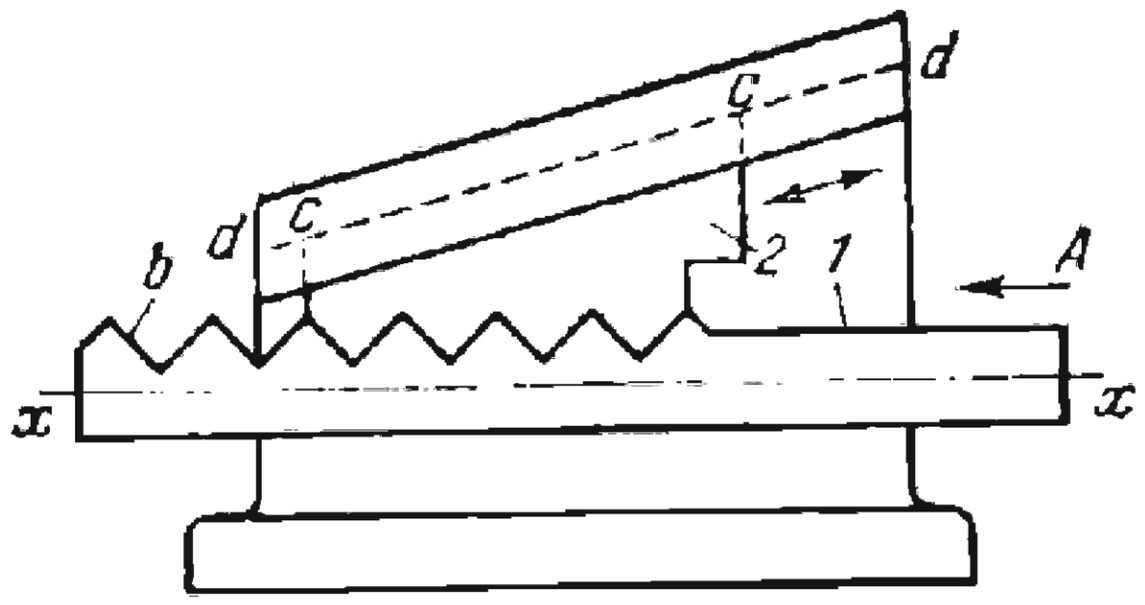
Link *1* slides along axis *x-x* in fixed guides and has, at its end, wedge-shaped teeth *a*. Link *2* rotates about fixed axis *y-y* and has wedge-shaped recesses *b* located around the circumference of disk *3*. Force *P* presses link *1* against the recesses of disk *3*, locking it against rotation in either direction.

2185	FORCE-ENGAGED WEDGE-TYPE STOP MECHANISM	WL SD



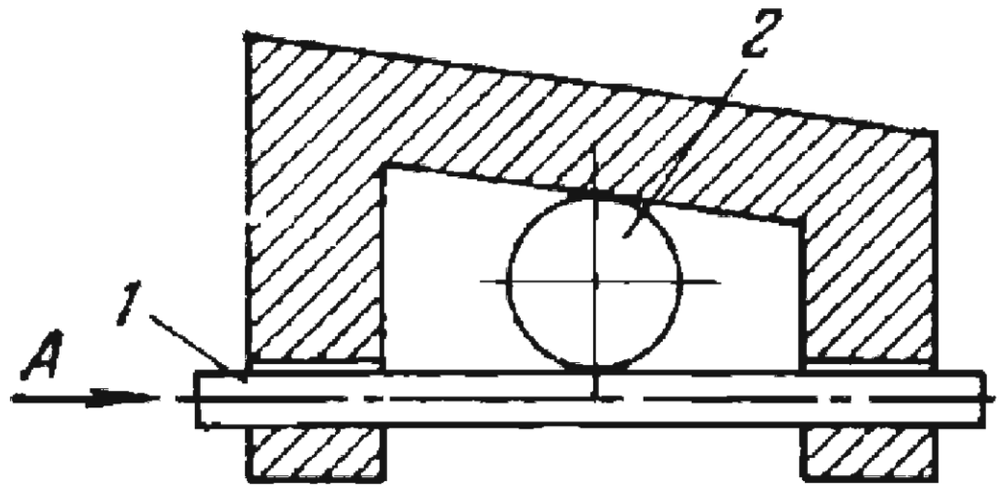
Link *1* slides along axis *y-y* in fixed guides and has, at its end, wedge-shaped teeth *a*. Rack *2* slides along axis *x-x* in fixed guides and has wedge-shaped tooth-spaces *b*. Force *P* presses link *1* against the recesses of rack *2*, locking it against motion in either direction.

2186	WEDGE-TYPE STOP MECHANISM	WL SD



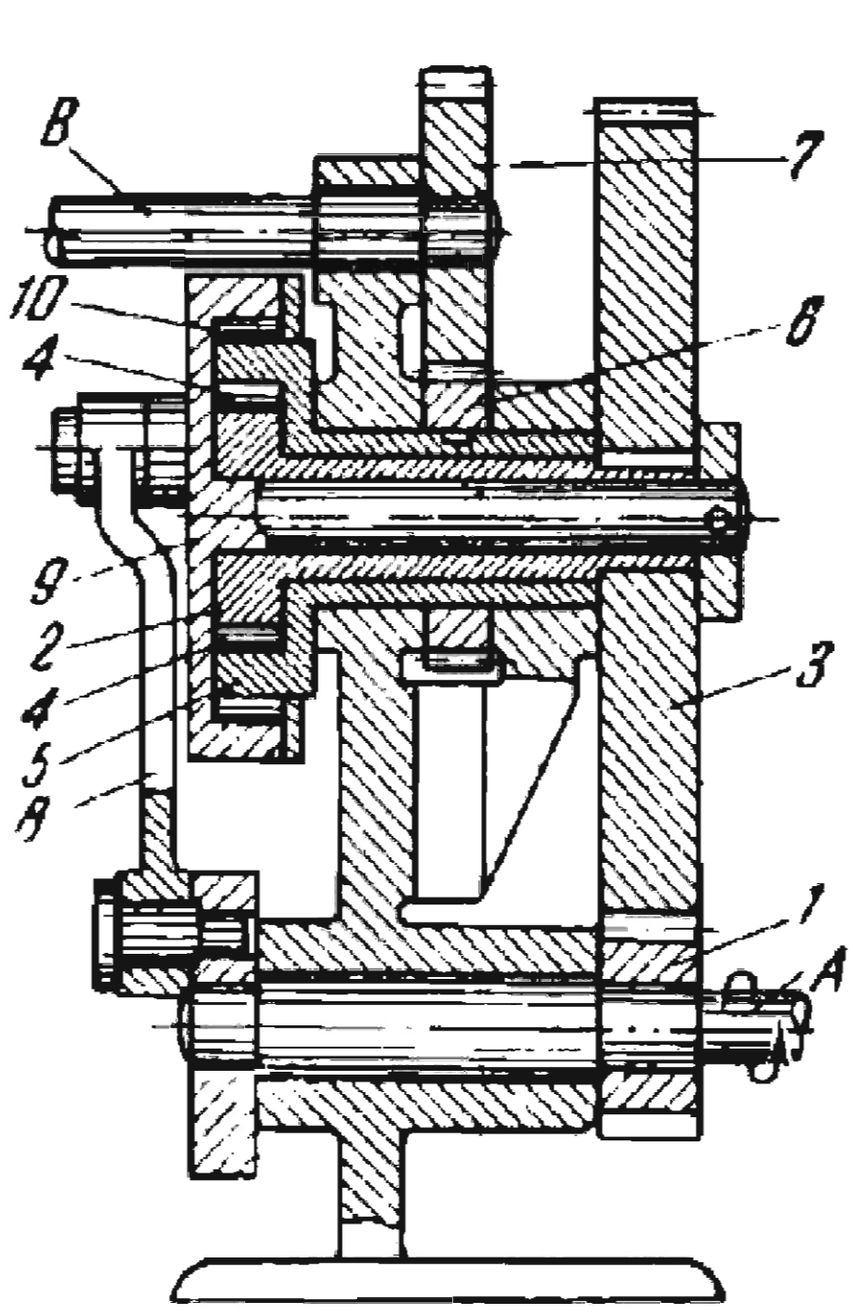
Rack *1* moves in a straight line along axis *x-x* and has wedge-shaped tooth spaces *b* which engage the wedge-shaped teeth of link *2*. Link *2* has one inclined edge *c-c*. Rack *1* is in constant engagement with link *2* and its motion is stopped when rack and link move to the left and reach the position shown where inclined edge *c-c* of link *2* comes into contact with inclined recess *d-d* of the base. The teeth and tooth spaces *b* are isosceles triangles.

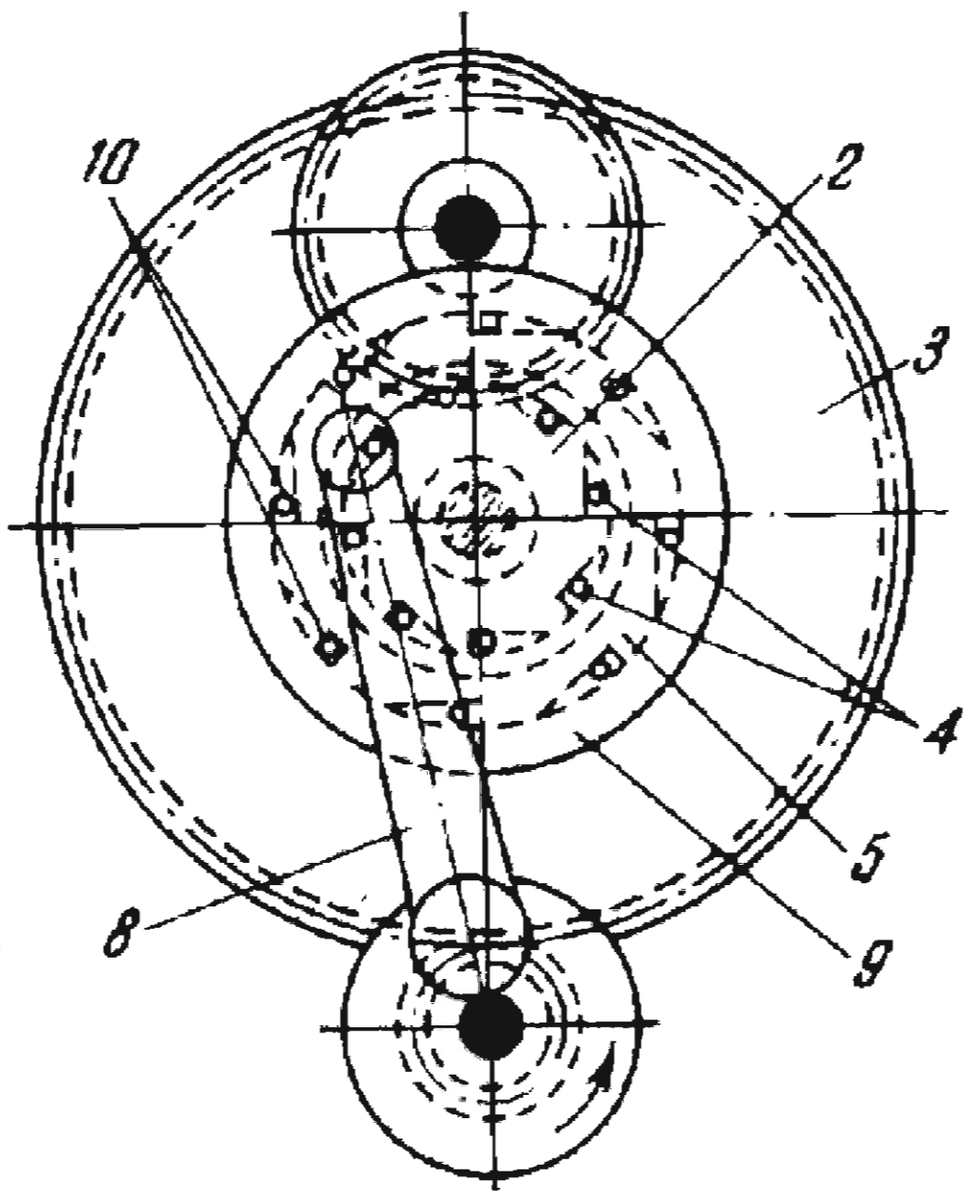
2187	WEDGE-TYPE STOP MECHANISM WITH A BALL	WL SD



Link *1* slides in fixed guides of the base. Ball *2* is arranged between link *1* and the base. When link *1* is moved to the right it is jammed by ball *2*.

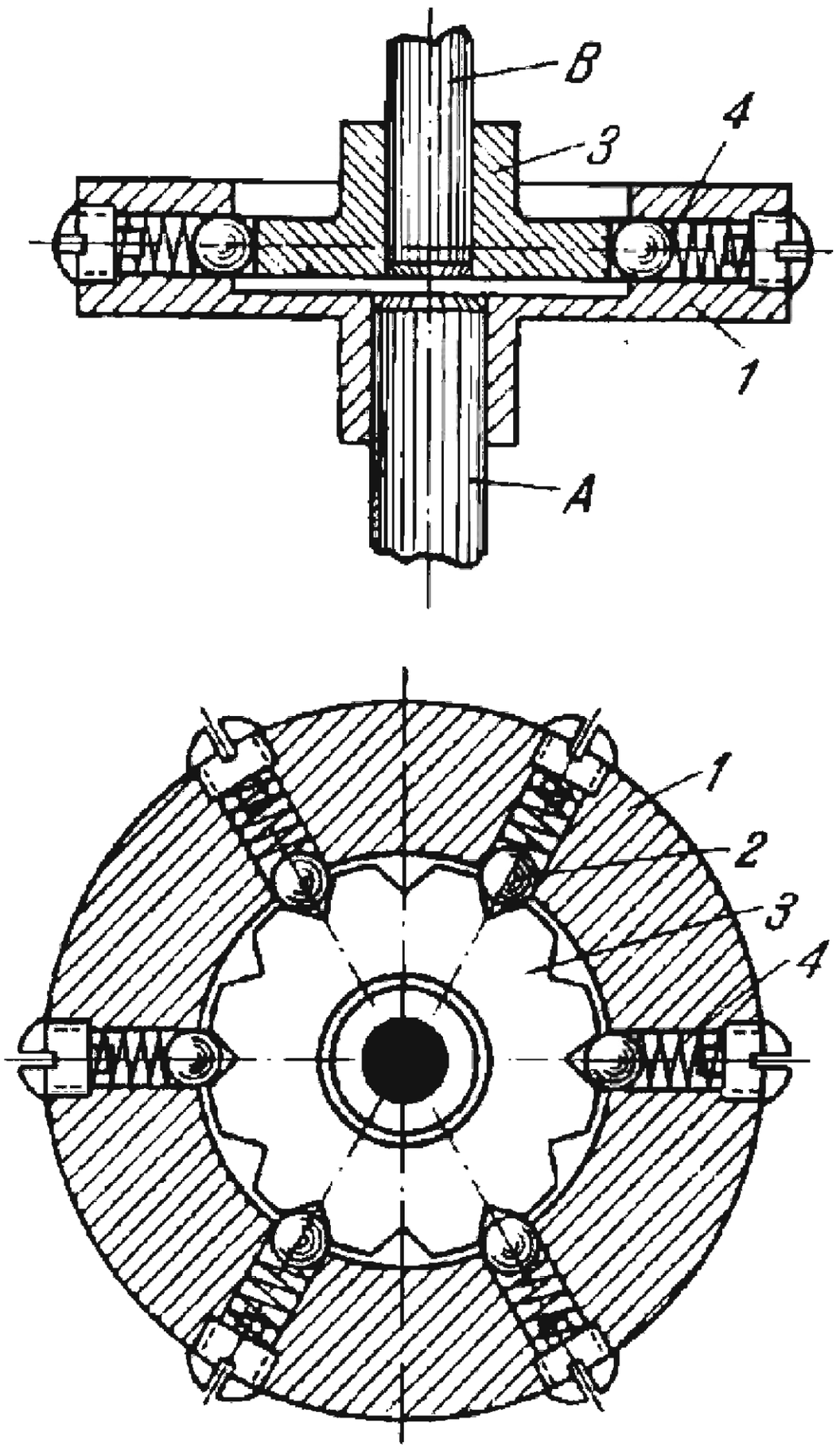
2188	WEDGE-LEVER FEED DRIVE MECHANISM WITH VARIABLE ROTARY MOTION	WL SF





Shaft *A*, on which pinion *1* is keyed, is driven at constant speed counterclockwise. Through meshing gears *1* and *3*, this rotates core sleeve *2* clockwise since gear *3* is keyed on sleeve *2*. Owing to the jamming of rolls *4*, outer ring *5* of this overrunning clutch is rotated in the same direction, this rotation being transmitted to shaft *B* through meshing gears *6* and *7* which are keyed on the sleeve of ring *5* and on shaft *B*. During the first half-revolution of shaft *A*, connecting rod *8* turns outer ring *9* of the second (outer) overrunning clutch counterclockwise; during the second half-revolution it turns outer ring *9* clockwise. Since a higher angular velocity is transmitted in this case to ring *9* than tc core sleeve *2*, rolls *10*, previously free, become jammed and outer ring *5* (now operating as a core sleeve) and shaft *B* are rotated at a higher angular velocity than in the first half-revolution of shaft *A*. Rolls *4* are free until connecting rod *8* begins to turn outer ring *9* counterclockwise again in the next half-revolution of shaft *A*. Thus shaft *B* rotates alternately at high and low speed, imparting the required pulsating motion to the feed mechanism.

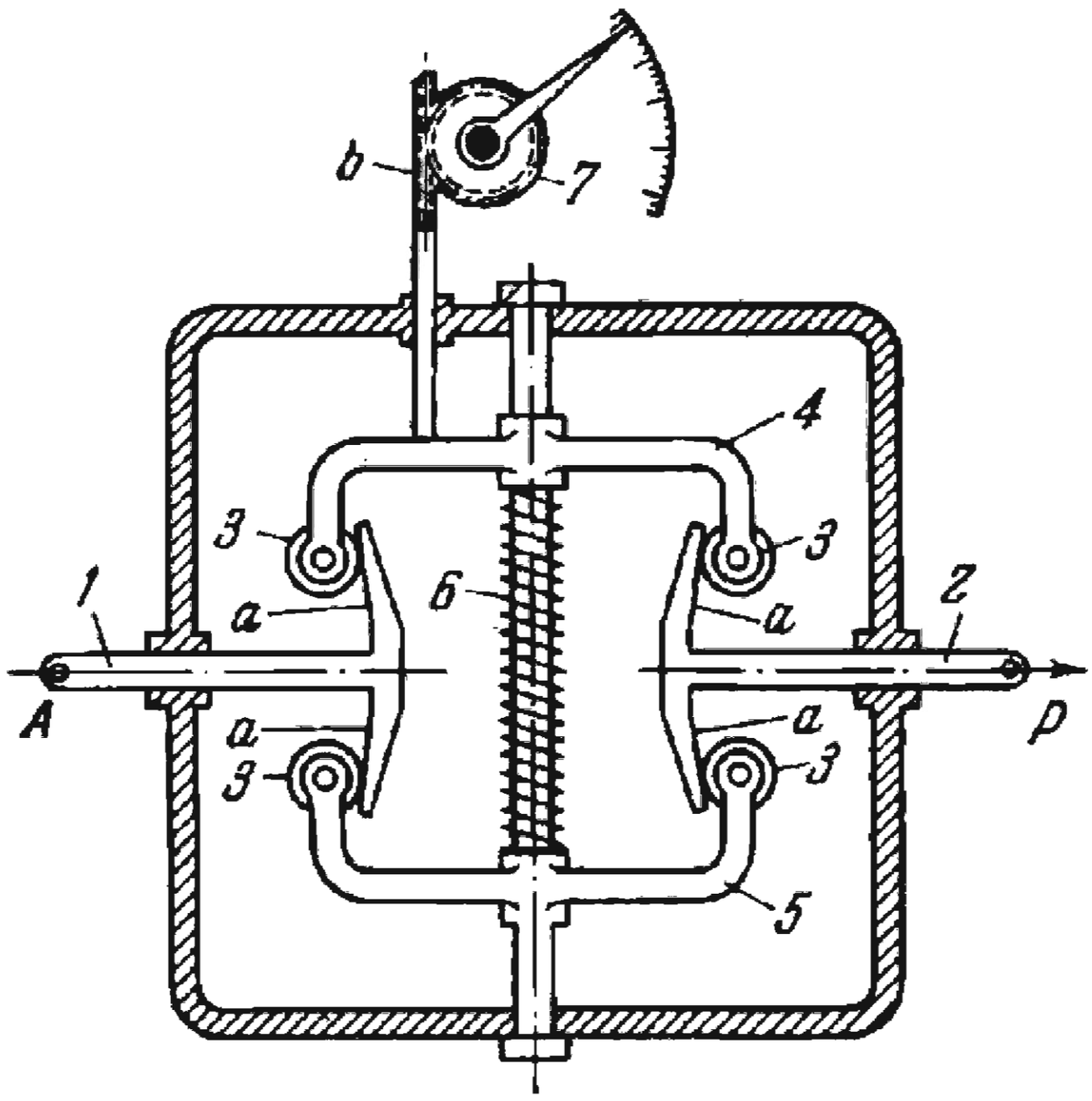
2189	WEDGE-TYPE BALL-OPERATED SAFETY CLUTCH	WL C



The rotation of disk *1*, keyed on driving shaft *A*, is transmitted through balls *2* to driven shaft *B*. Balls *2* enter recesses in disk *3* which is keyed on shaft *B*. When the torque applied to shaft *B* exceeds the permissible value, balls *2* overcome the resistance of springs *4* and are forced out of the recesses of disk *3*. This stops the transmission of rotation from shaft *A* to shaft *B*.

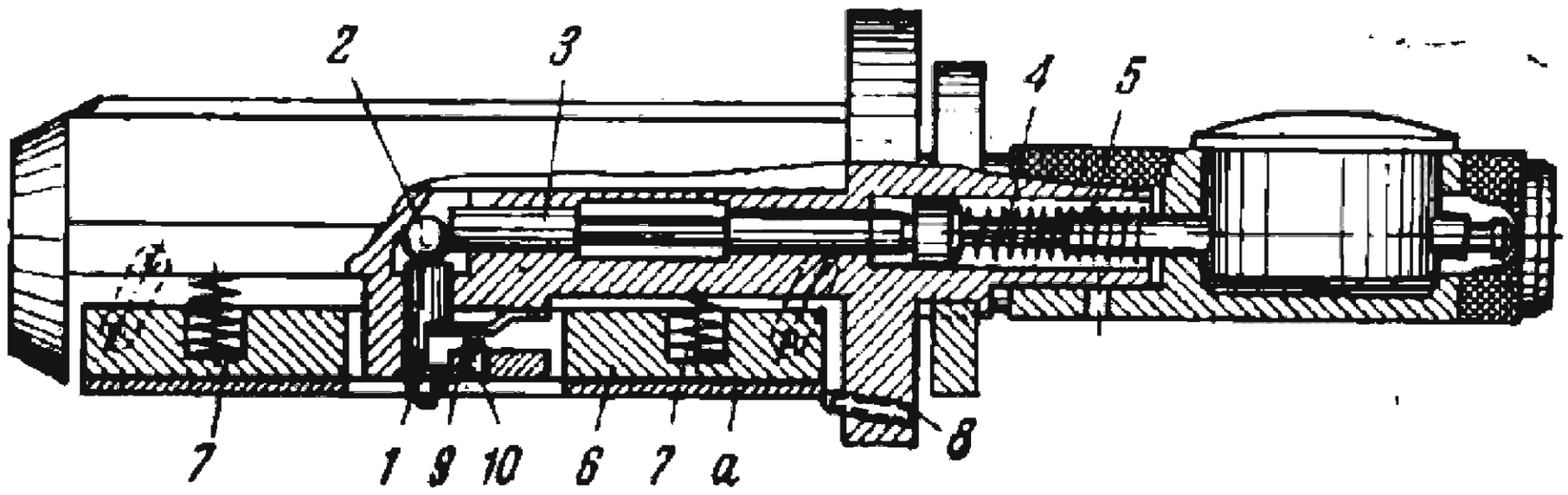
8. MECHANISMS OF MEASURING AND TESTING DEVICES (2190, 2191 and 2192)

2190	WEDGE-LEVER MECHANISM OF THE DRONOV-LOKAI DYNAMOMETER	WL M



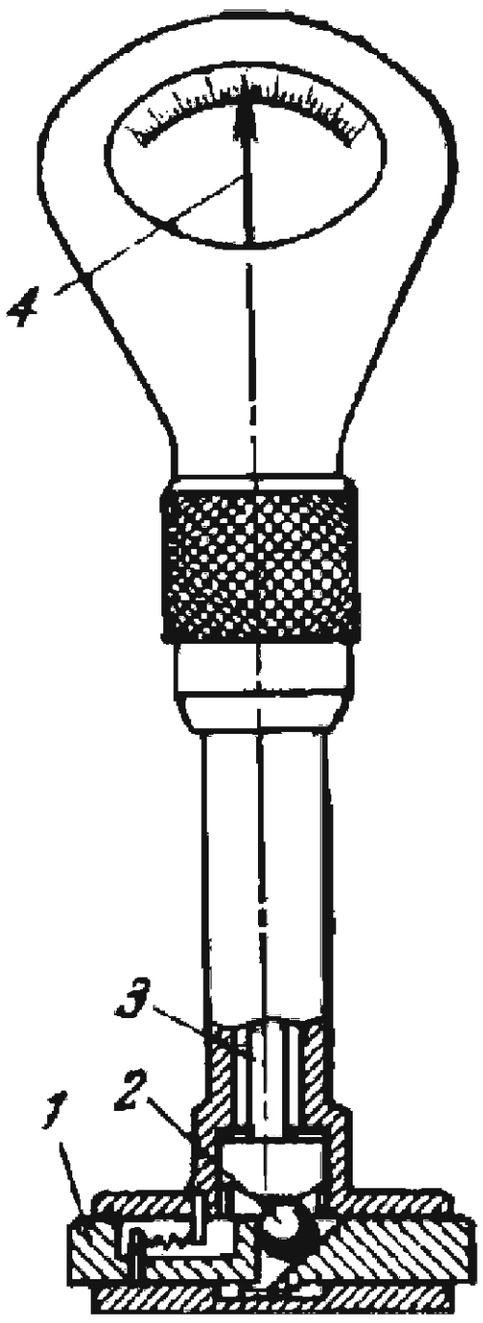
Tie-rod *1* is secured to fixed point *A*. Force *P*, applied to tie-rod *2*, brings links *4* and *5* closer together since rollers *3* are forced to roll down inclined surfaces *a*. This compresses spring *6*. The displacement of link *4* is transmitted by rack *b* to pinion *7* whose hand indicates the magnitude of applied force *P*. When tie-rod *2* is released, spring *6* returns links *4* and *5* to their initial positions.

2191 WEDGE-TYPE MECHANISM OF A BORE GAUGE — WL M



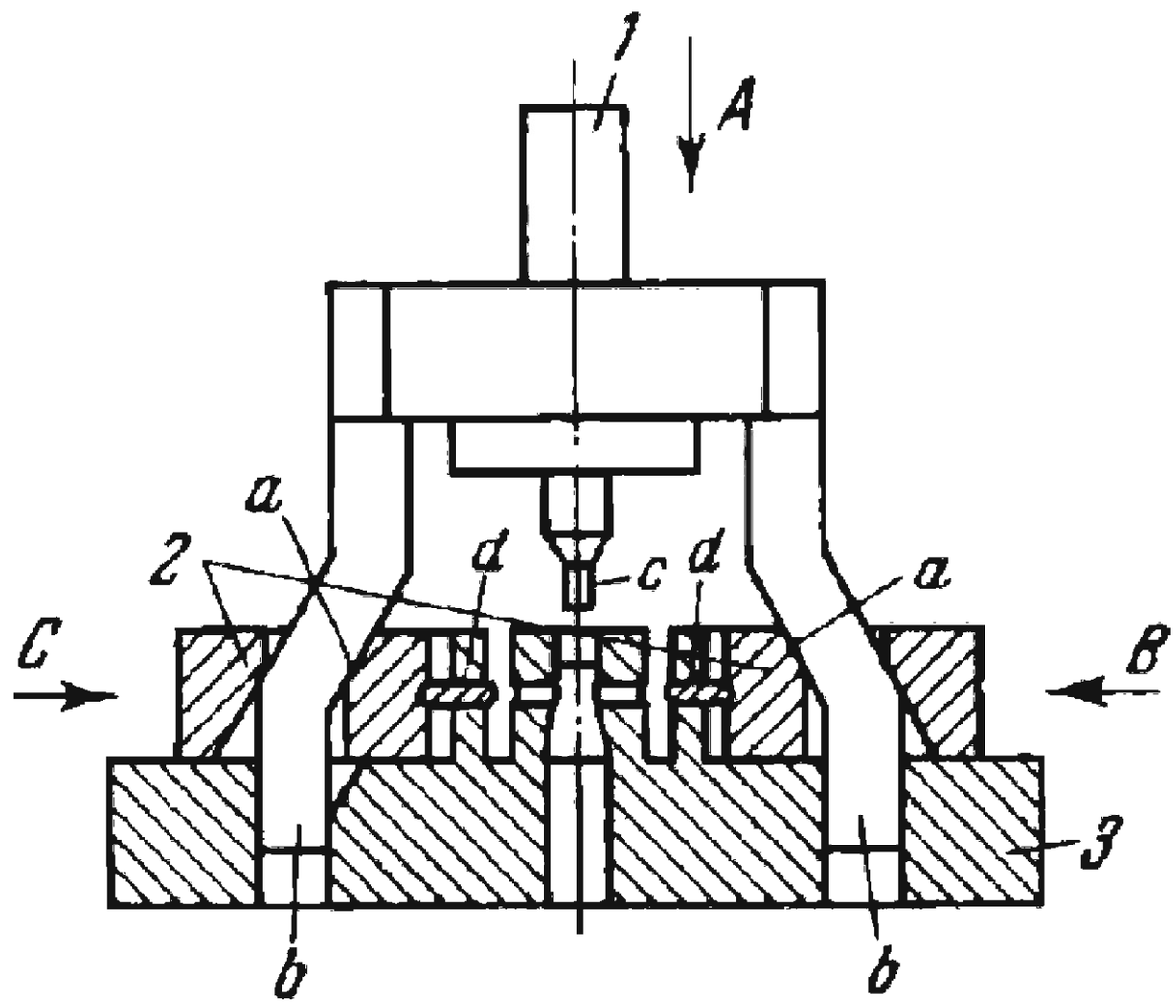
If the bore being measured deviates from the required diameter, the displacement of pin *1* is transmitted through ball *2*, bearing against an inclined surface, and rod *3* to contact point *4* of a dial indicator. Spring *5* holds parts *1*, *2* and *3* in contact with each other. Strip *6* with plates *a* is held against the walls of the bore by springs *7*. The displacement of strip *6* is adjusted by screw *8*. The motion of pin *1* (range of measurement) is adjusted by spring *9* which, in turn, is adjusted by screw *10*. This enables the required initial deflection of the indicator hand to be obtained.

2192 WEDGE-TYPE BORE GAUGE — WL M



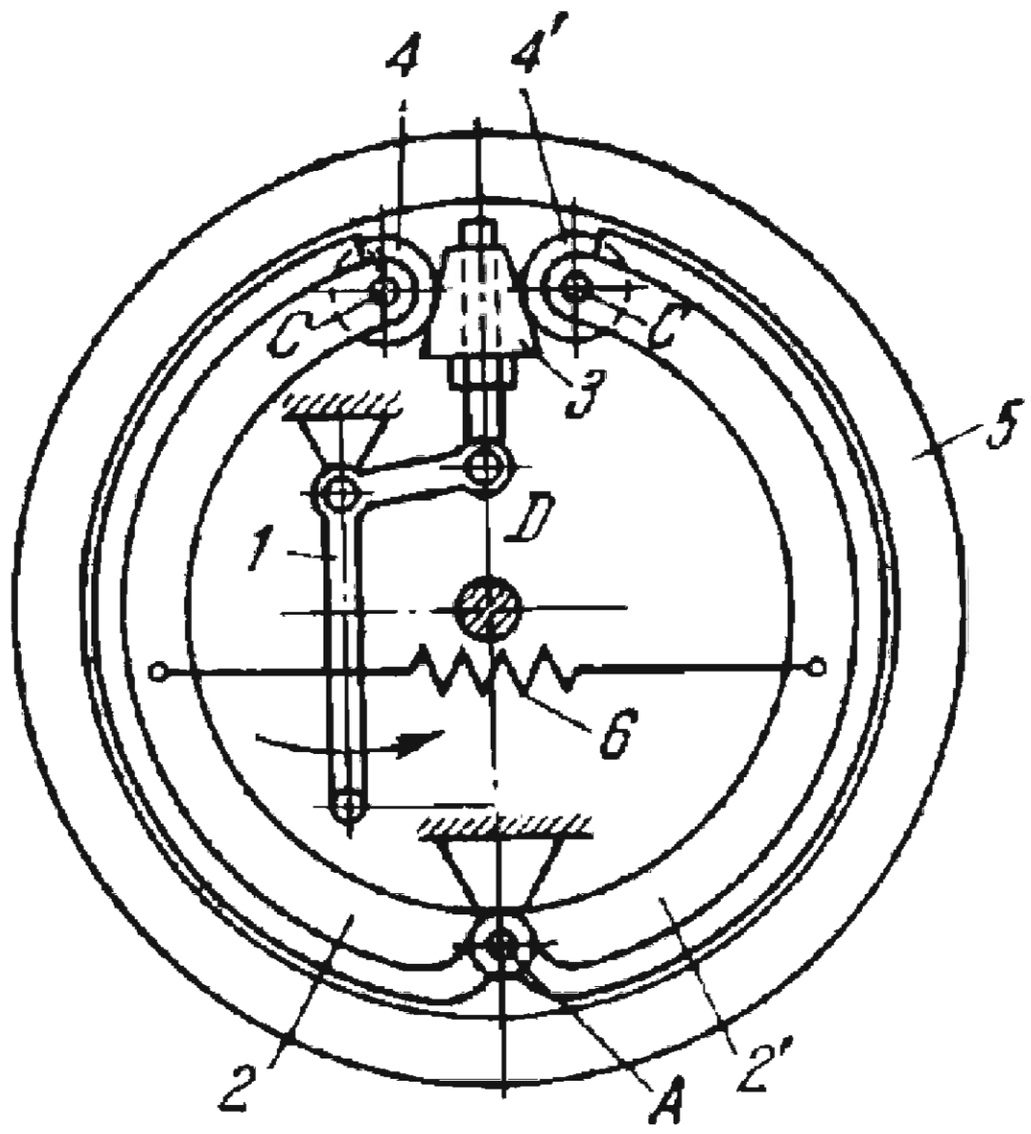
The displacement of contact pin *1* is transmitted through ball *2* to rod *3* and further, through a lever system, to hand *4* of the instrument. If the gauge is turned with respect to the hole axis, the deviation of the hand indicates the amount the bore is out-of-round. If the gauge is moved along the bore axis, the hand indicates the taper of the bore.

2193	WEDGE-TYPE DIE MECHANISM	WL HP



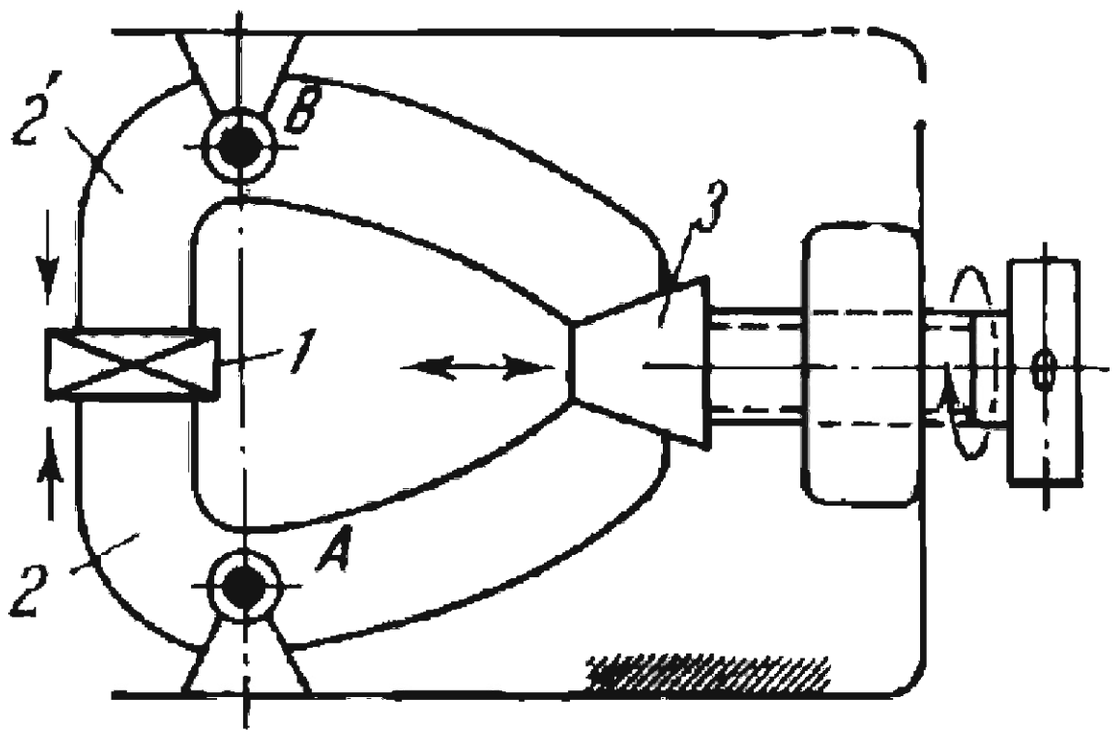
Rigidly attached to top die member *1* are dogleg cams whose lower ends *b* slide in fixed guides of bottom die member *3*. These dogleg cams have inclined surfaces *a* which slide along the corresponding surfaces of sliding members *2*. In the downstroke of top die member *1*, sliding members *2* are moved horizontally inward (arrows *B* and *C*). At this, punches *c* and *d* perform the required pressworking operations.

2194	WEDGE-LEVER MECHANISM OF AN INTERNAL SHOE BRAKE	WL Br



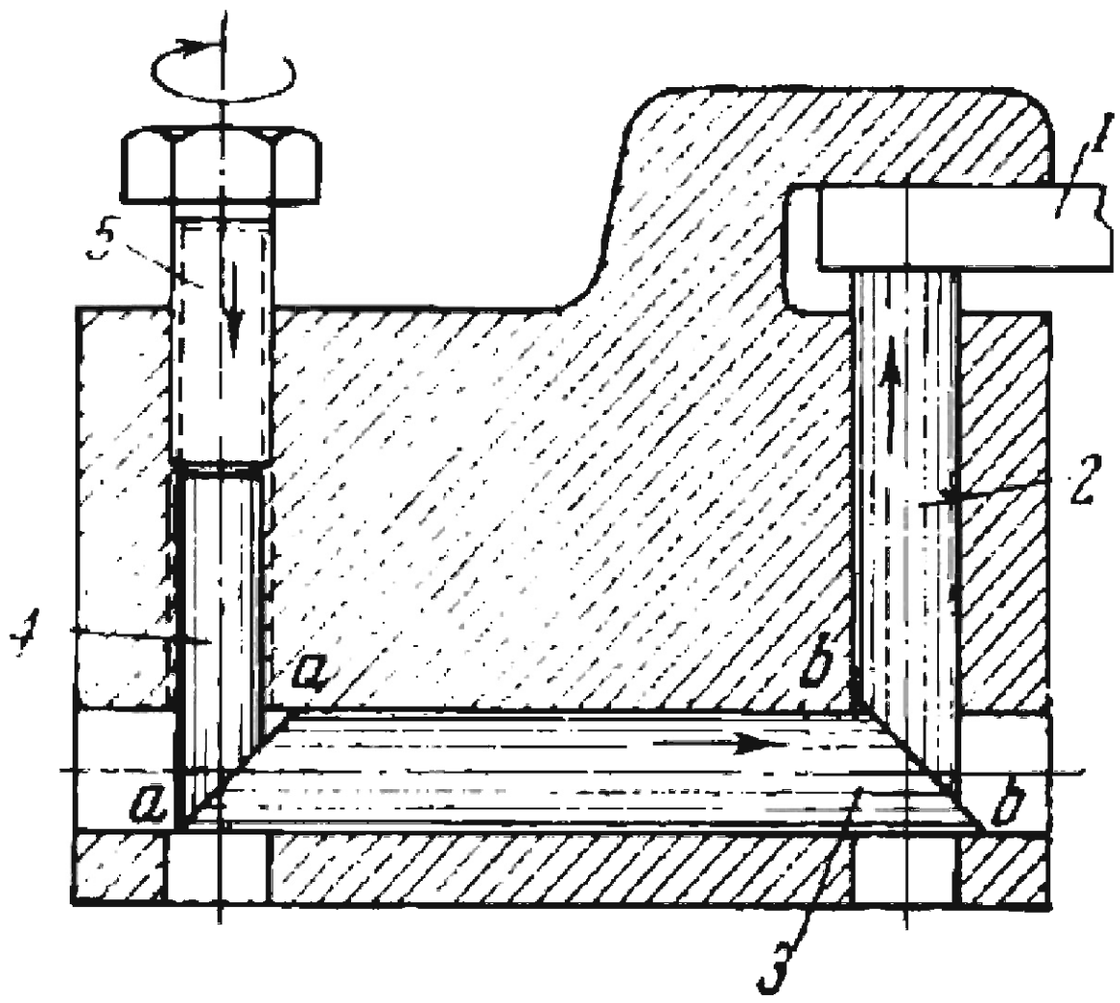
Shoes *2* and *2'* turn about axis *A* and are connected by turning pairs *C* to rollers *4* and *4'*. Lever *1* is connected by turning pair *D* to wedge *3*. Shoes *2* and *2'* are pulled toward each other by spring *6*. Shoes *2* and *2'* are forced against the drum of wheel *5* by wedge *3* which spreads rollers *4* and *4'* when lever *1* is turned counterclockwise.

2195	WEDGE-LEVER CLAMPING MECHANISM	WL GC



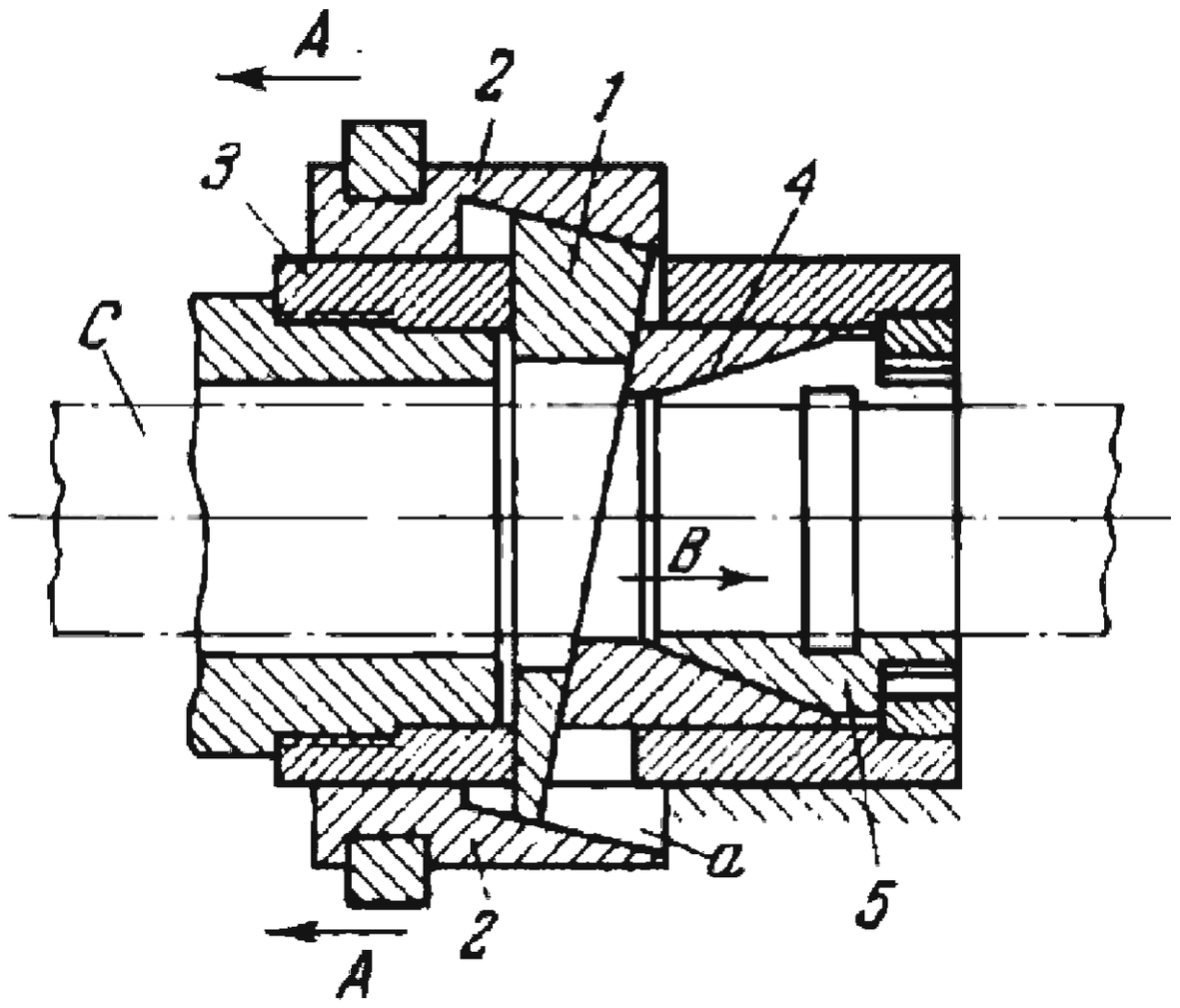
Workpiece *1* is clamped by levers *2* and *2'* which turn about fixed axes *A* and *B* when their ends are forced apart by wedge *3*. Wedge *3* is advanced by a screw.

2196	WEDGE-TYPE CLAMPING MECHANISM	WL GC



Screw *5* advances link *4* which has bevel *a-a* at its lower end. Link *4* slides along the bevel of link *3*, moving it in the horizontal direction. Link *3* has bevel *b-b* at its right end. Link *2* slides along the bevel of link *3* and is thus advanced to clamp workpiece *1*.

2197	WEDGE-TYPE MECHANISM OF A CHUCK	WL GC

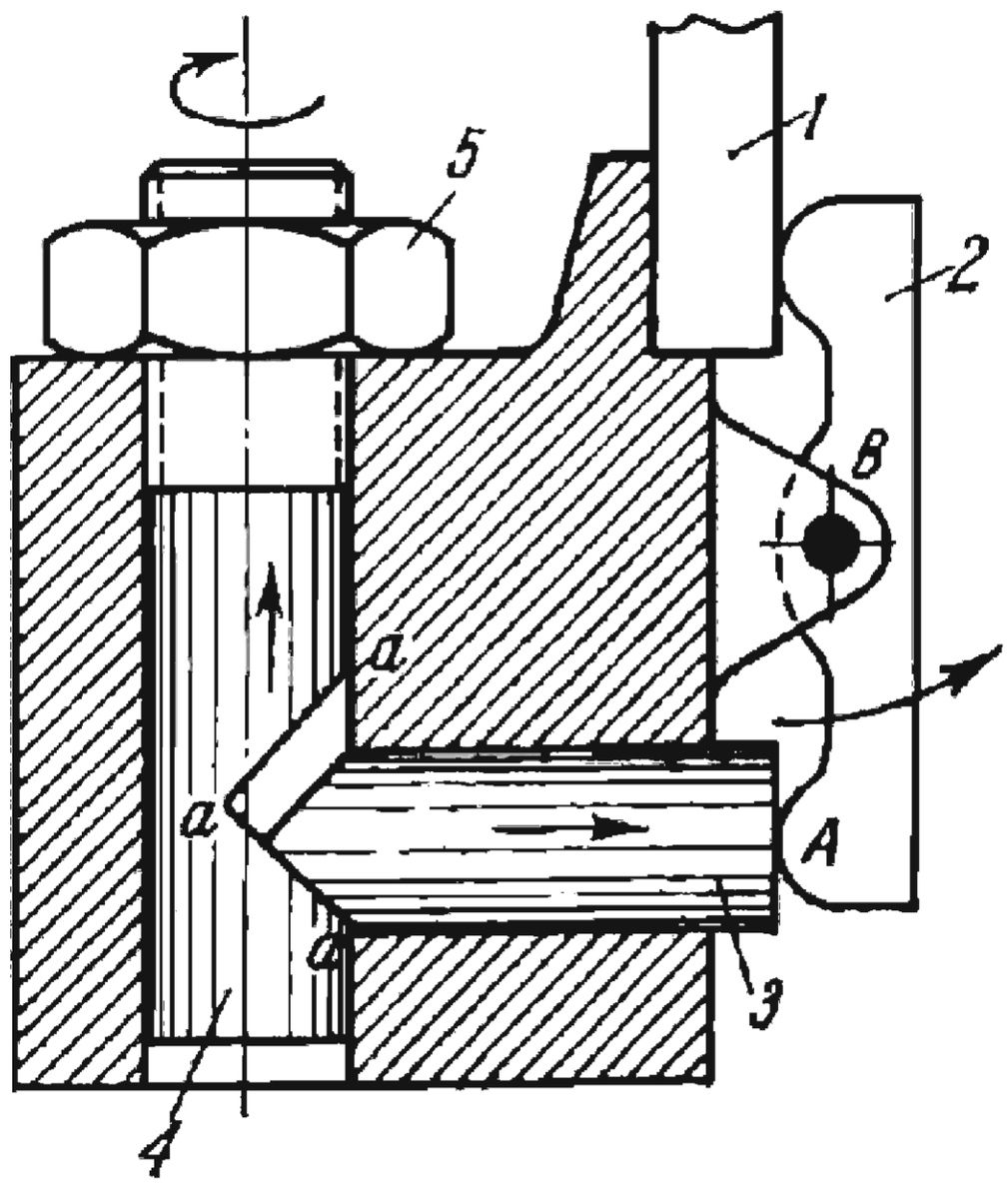


Annular link *2* slides along fixed link *3* and has cylindrical hole *a* bored at an angle to the axis of the link. Link *2* is connected by a sliding pair to link *1*, designed as a wedge-shaped piece of a hollow cylinder. Link *1* is connected by a sliding pair to tapered sleeve *4* whose inclined end contacts an end face of link *1*. Tapered sleeve *4* fits over split tapered collet *5*. When link *2* is shifted to the left (arrow *A*), link *1* forces tapered sleeve *4* to the right (arrow *B*), compressing split collet *5* which clamps bar stock *C*.

2198

NUT-OPERATED WEDGE-LEVER CLAMPING MECHANISM

WL
GC

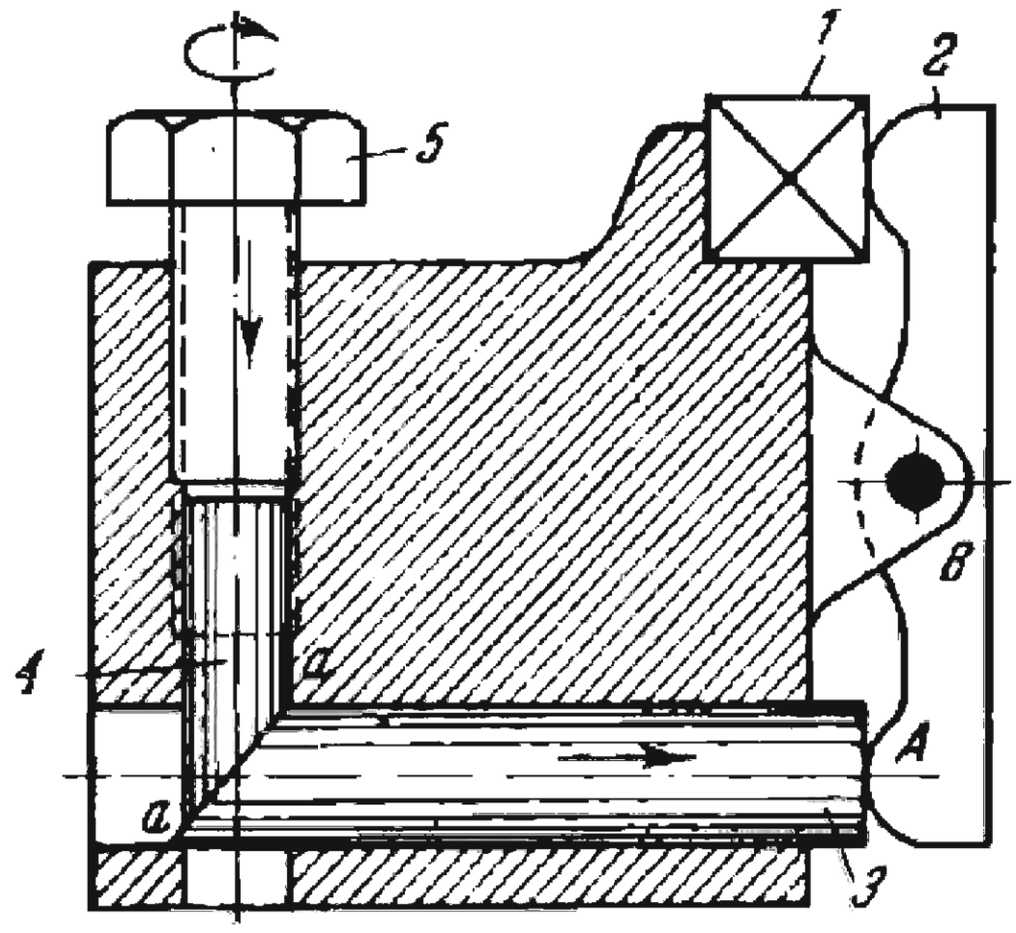


Link *4* has screw thread on which nut *5* is screwed. When nut *5* is turned clockwise (screwed on) link *4* is pulled upward. Double-bevel recess *a-a* in link *4* engages the bevelled end of link *3* pushing it in the horizontal direction. At point *A* link *3* pushes lever *2*, turning it about fixed axis *B* to clamp workpiece *1*.

2199

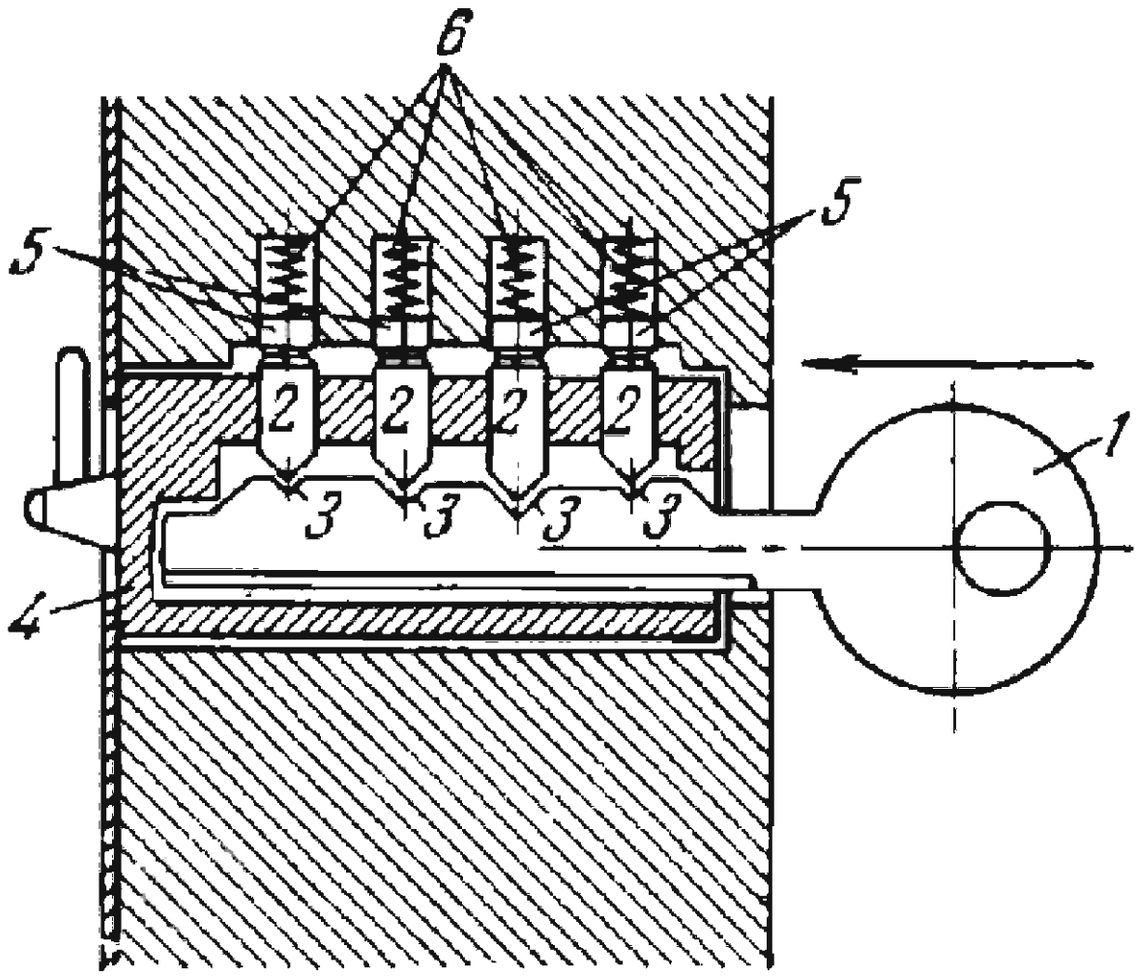
SCREW-OPERATED WEDGE-LEVER CLAMPING MECHANISM

WL
GC



Screw *5* advances link *4* which has bevel *a-a* at its lower end. Link *4* slides along the bevel of link *3*, moving it in the horizontal direction. At point *A* link *3* pushes lever *2*, turning it about fixed axis *B* to clamp workpiece *1*.

2200	WEDGE-TYPE LOCK MECHANISM	WL FD



Key *1* has wedge-shaped notches *3* of various sizes. Cylindrical tumbler *4* has holes with pins *2*. The lengths of pins *2* are such that when their lower ends enter the corresponding notches of the key (as shown) their upper ends are flush with the surface of the tumbler, holding pins *5* in holes of the fixed part of the lock and keeping them out of the holes in tumbler *4*. Under this condition, tumbler *4* can be turned by key *1*, opening the lock. If a key is inserted with notches of different size, some of pins *2* will extend into the holes of the fixed part of the lock and some of pins *5* will extend into the holes in tumbler *4*. In this case it will be impossible to turn the tumbler and open the lock with this key. Pins *2* and *5* are held in contact with each other by springs *6*.

SECTION TWELVE

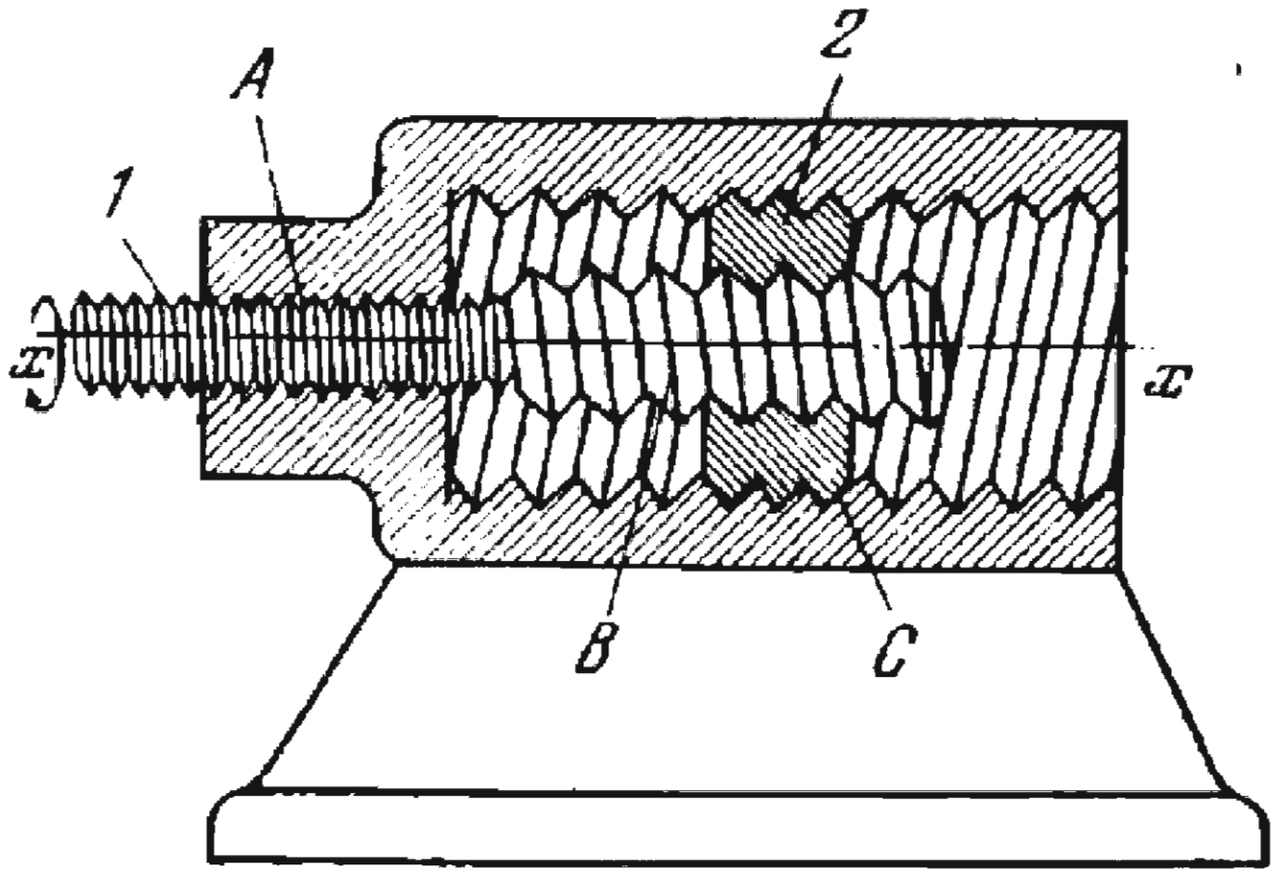
Lever-Screw Mechanisms

LS

1. General-Purpose Three-Link Mechanisms 3L (2201 through 2225)
2. General-Purpose Four-Link Mechanisms 4L (2226, 2227 and 2228)
3. General-Purpose Five-Link Mechanisms 5L (2229 through 2237)
4. General-Purpose Multiple-Link Mechanisms ML (2238, 2239 and 2240)
5. Sorting and Feeding Mechanisms SF (2241)
6. Hammer, Press and Die Mechanisms HP (2242, 2243 and 2244)
7. Switching, Engaging and Disengaging Mechanisms SE (2245 and 2246)
8. Governor Mechanisms G (2247 and 2248)
9. Mechanisms of Materials Handling Equipment MH (2249)
10. Precise Setting Mechanisms PS (2250 through 2254)
11. Mechanisms for Mathematical Operations MO (2255 through 2266)
12. Brake Mechanisms Br (2267)
13. Mechanisms of Measuring and Testing Devices M (2268 through 2271)
14. Mechanisms of Other Functional Devices FD (2272 through 2288)

1. GENERAL-PURPOSE THREE-LINK MECHANISMS
(2201 through 2225)

2201	THREE-LINK SCREW-TYPE MECHANISM	LS [3L

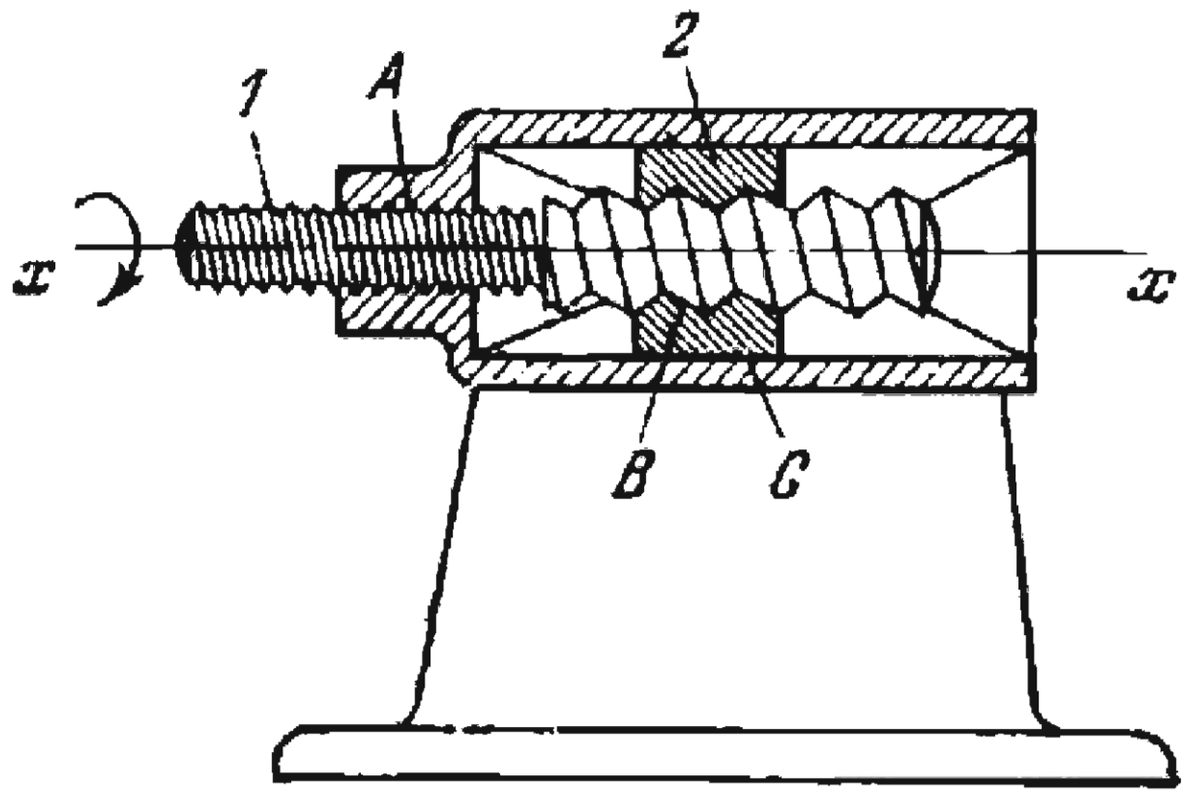


Link *1* is connected by screw pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. Screw motion of link *1* is converted into screw motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* is

$$s_2 = h_C \frac{h_A - h_B}{h_C - h_B} \frac{\varphi_1}{2\pi}$$

where h_A, h_B and h_C are the pitches of the threads in screw pairs *A*, *B* and *C*. These pitches are taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2202	THREE-LINK SCREW-TYPE MECHANISM WITH A SLIDING PAIR	LS 3L

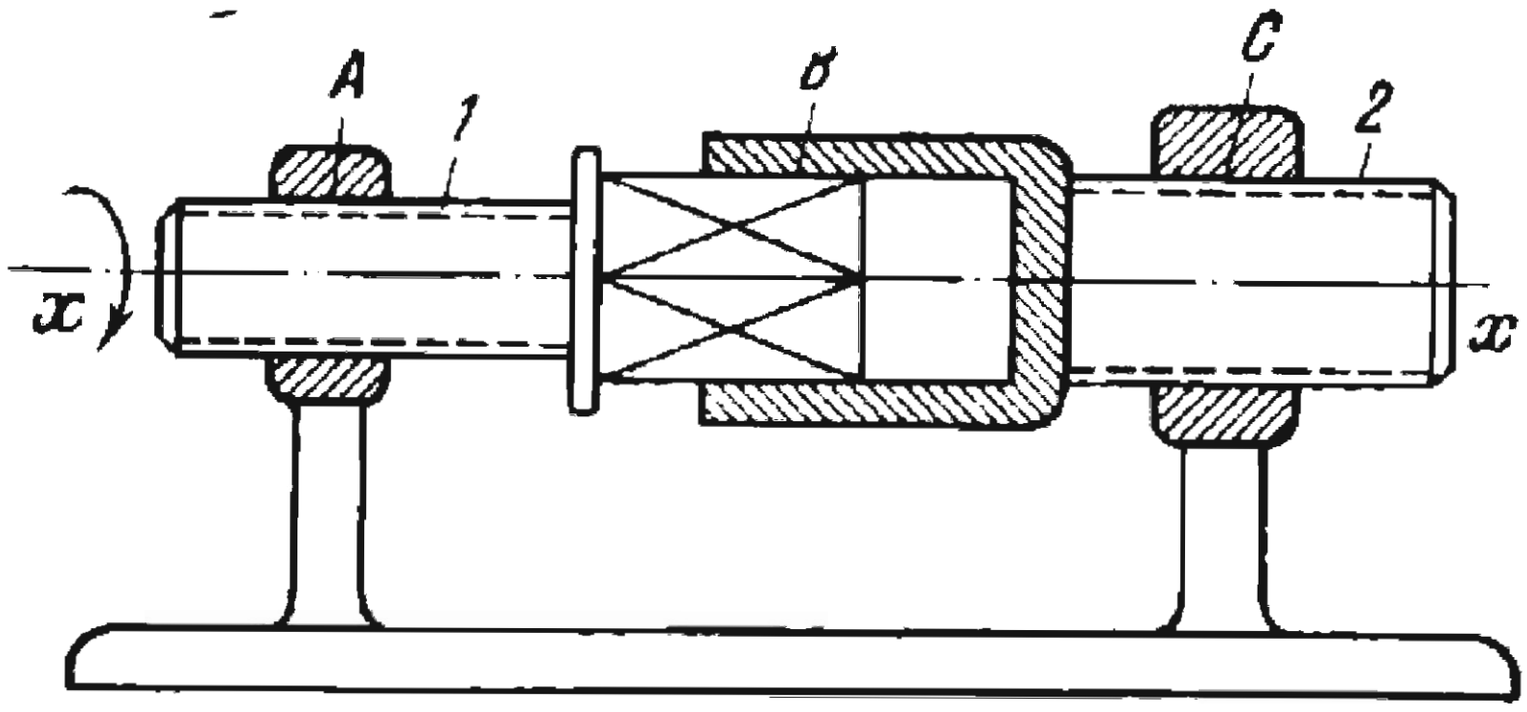


Link *1* is connected by screw pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = (h_A - h_B)\frac{\varphi_1}{2\pi}$$

where h_A and h_B are the pitches of the threads in screw pairs *A* and *B*. These pitches are taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2203	THREE-LINK SCREW-TYPE MECHANISM WITH A SLIDING PAIR	LS 3L



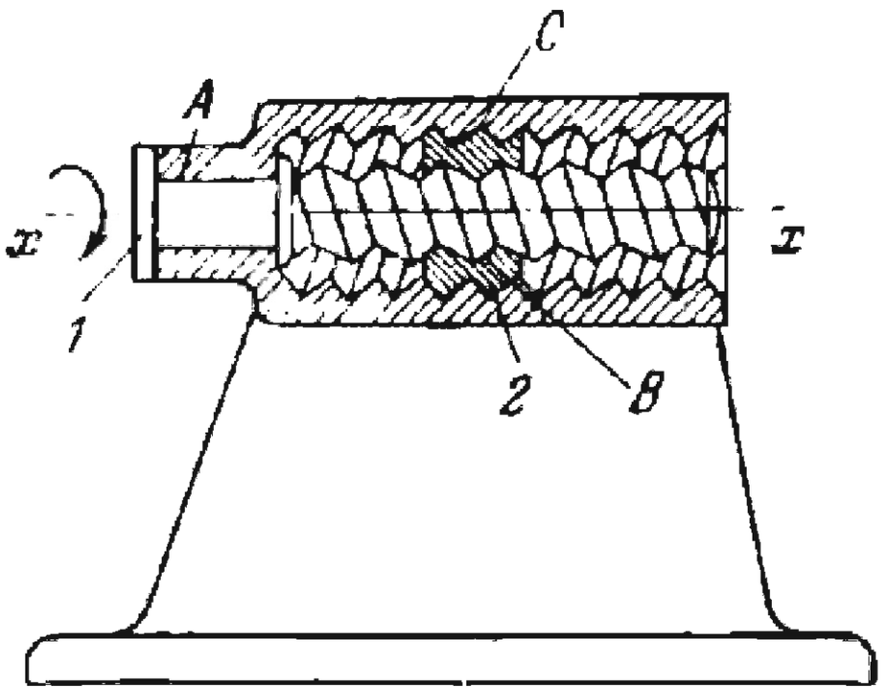
Link *1* is connected by screw pair *A* to the fixed link and by sliding pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = h_C \frac{\varphi_1}{2\pi}$$

where h_C is the pitch of the thread in screw pair *C*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread. The angles of rotation φ_1 and φ_2 of links *1* and *2* are equal.

2204 THREE-LINK SCREW-TYPE MECHANISM WITH A TURNING PAIR

LS 3L



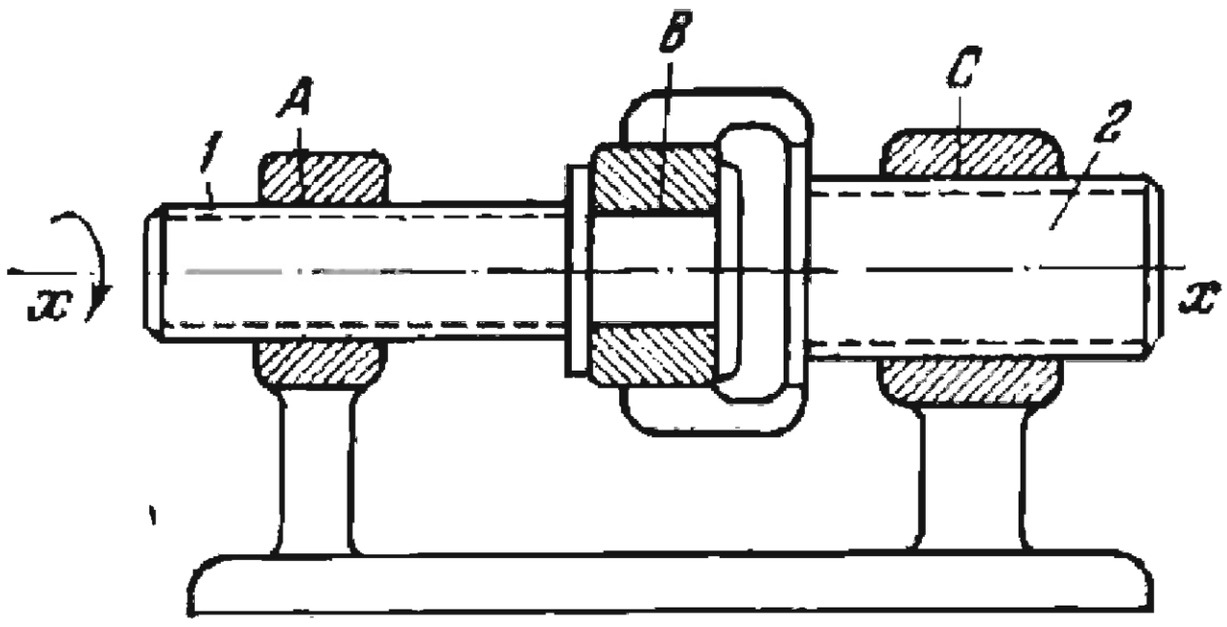
Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = -\frac{h_B h_C}{h_C - h_B}\frac{\varphi_1}{2\pi}$$

where h_B and h_C are the pitches of the threads in screw pairs *B* and *C*. These pitches are taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2205 THREE-LINK SCREW-TYPE MECHANISM WITH A TURNING PAIR

LS 3L



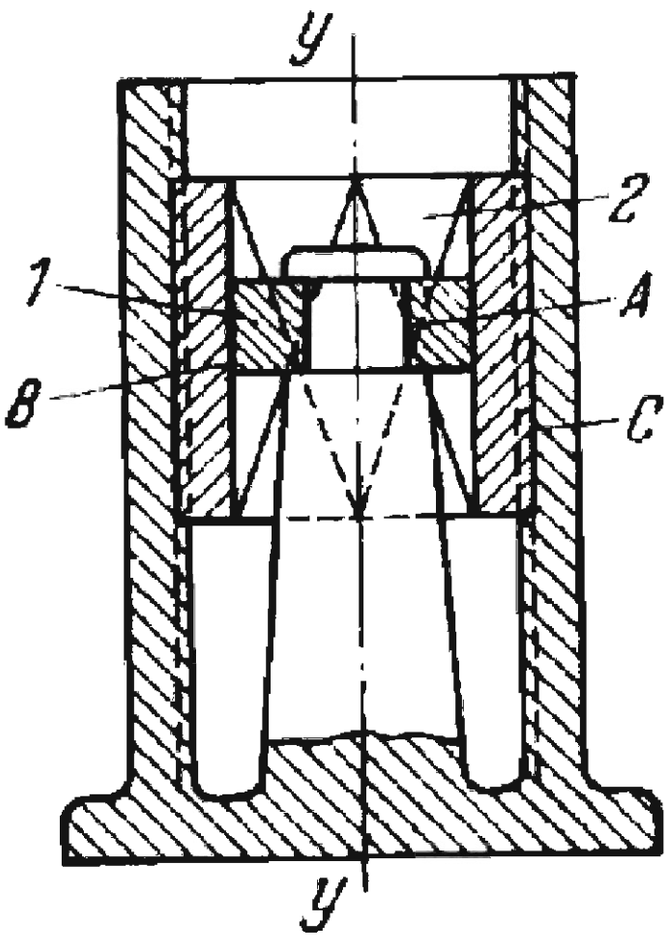
Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. The angles of rotation φ_1 and φ_2 of links *1* and *2* are related by the equation

$$\varphi_1 = \frac{h_C}{h_A}\varphi_2$$

where h_A and h_C are the pitches of the threads in screw pairs *A* and *C*. These pitches are taken with a plus sign for right-hand thread and with a minus sign for left-hand thread. If link *1* is the driving link, the helix angle of the thread of link *2* must be greater than the angle of friction of the pair.

2206 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS
3L



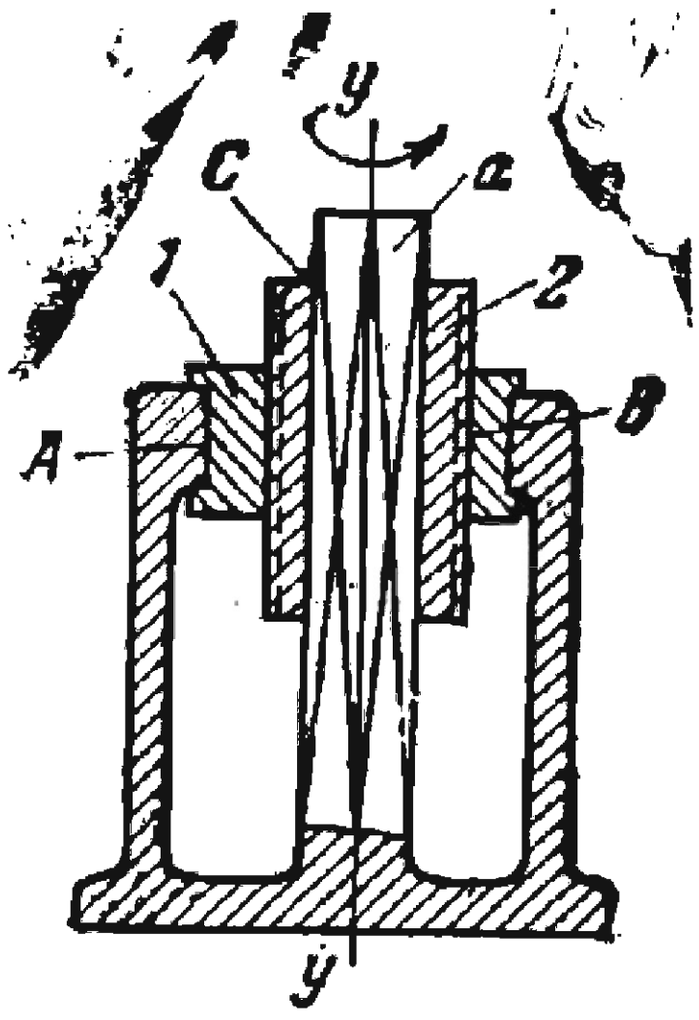
Link *1* is connected by turning pair *A* to the fixed link and by sliding pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. Link *2*, designed as a hollow cylinder with external thread, has a prismatic hole by means of which it slides along prismatic link *1*. Rotation of link *1* is converted into screw motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *y-y* is

$$s_2 = h_C \frac{\varphi_1}{2\pi}$$

where h_C is the pitch of the thread in screw pair *C*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2207 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS
3L



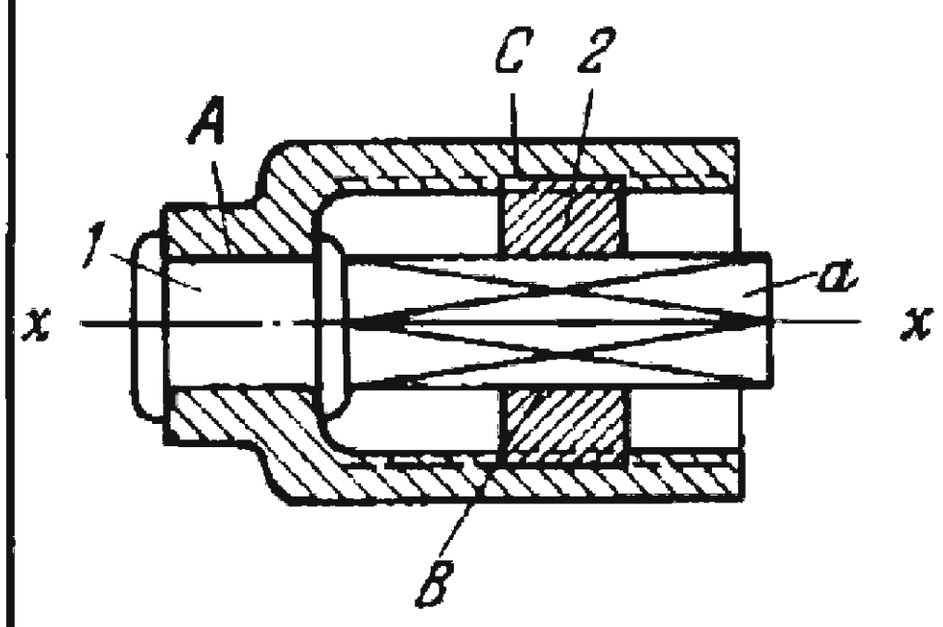
Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *2*, designed as a hollow cylinder with external thread, has a prismatic hole by means of which it slides along prismatic shank *a* of the fixed link. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *y-y* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2208 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L



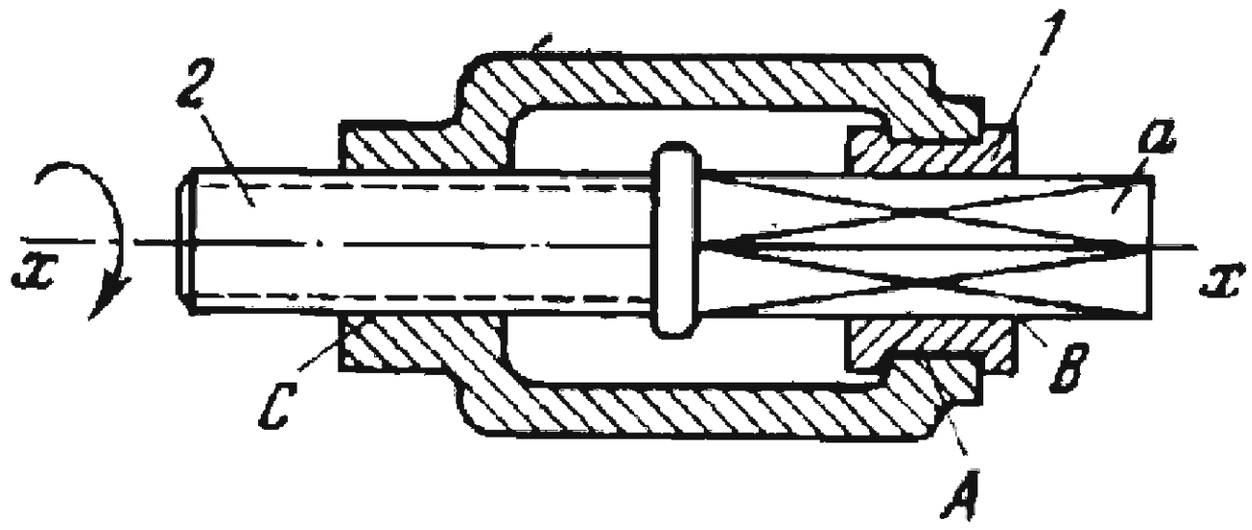
Link *1* is connected by turning pair *A* to the fixed link and by sliding pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. Link *2*, designed as a ring, has a prismatic hole by means of which it slides along prismatic shank *a* of link *1*. On the outside, the ring has external thread. Rotation of link *1* is converted into screw motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = h_C \frac{\varphi_1}{2\pi}$$

where h_C is the pitch of the thread in screw pair *C*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2209 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L

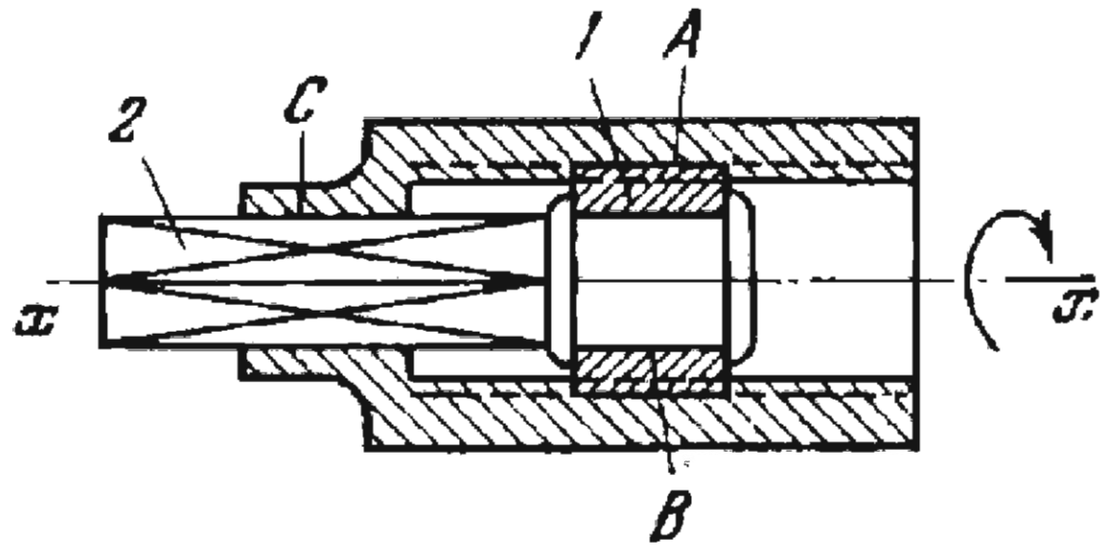


Link *1* is connected by turning pair *A* to the fixed link and by sliding pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. Link *1* has a prismatic hole in which prismatic shank *a* of link *2* slides. Rotation of link *1* is converted into screw motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = h_C \frac{\varphi_1}{2\pi}$$

where h_C is the pitch of the thread in screw pair *C*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2210	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

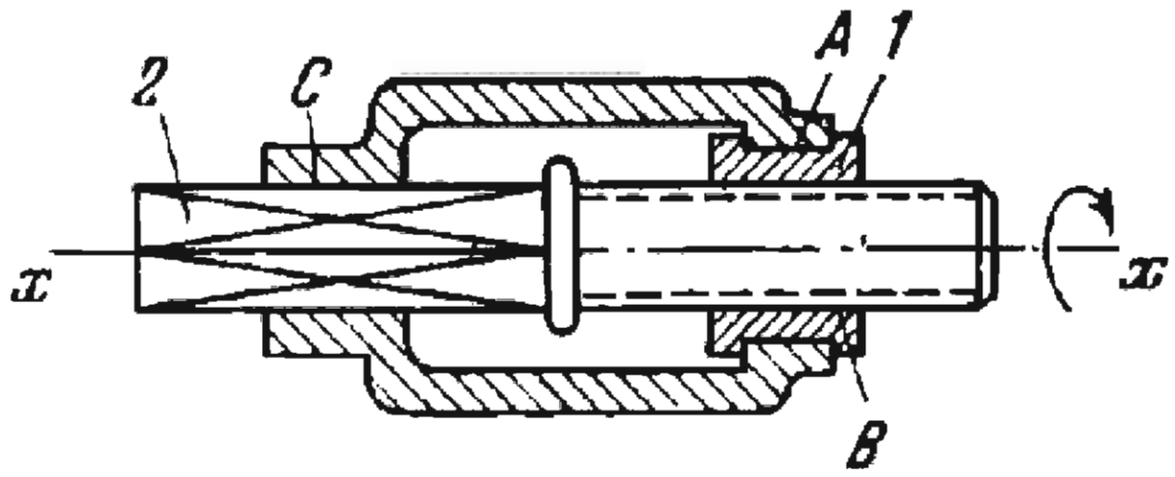


Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. The element of sliding pair *C* belonging to link *2* is designed as a prismatic shank. Screw motion of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = h_A \frac{\varphi_1}{2\pi}$$

where h_A is the pitch of the thread in screw pair *A*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2211	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

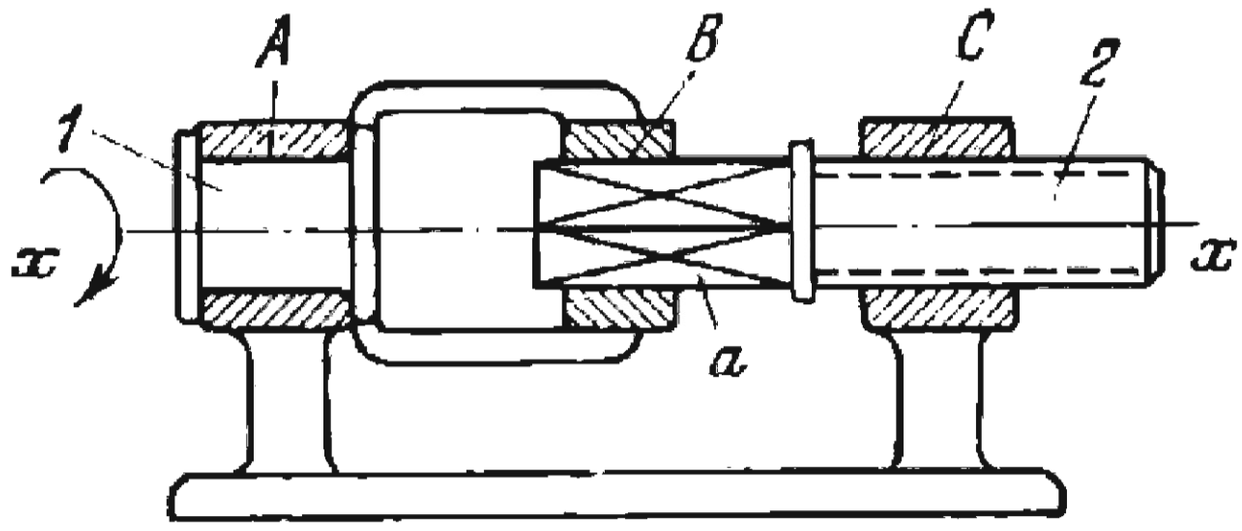


Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2212	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

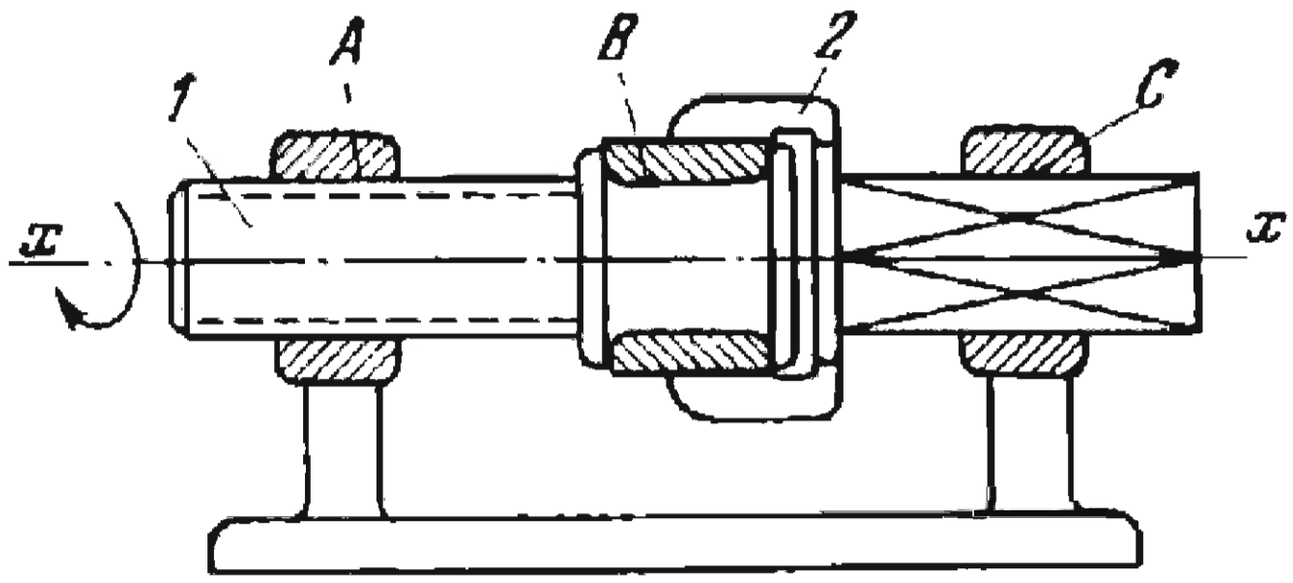


Link *1* is connected by turning pair *A* to the fixed link and by sliding pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. The element of sliding pair *B* belonging to link *2* is designed as prismatic shank *a*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = h_C \frac{\varphi_1}{2\pi}$$

where h_C is the pitch of the thread in screw pair *C*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2213	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L



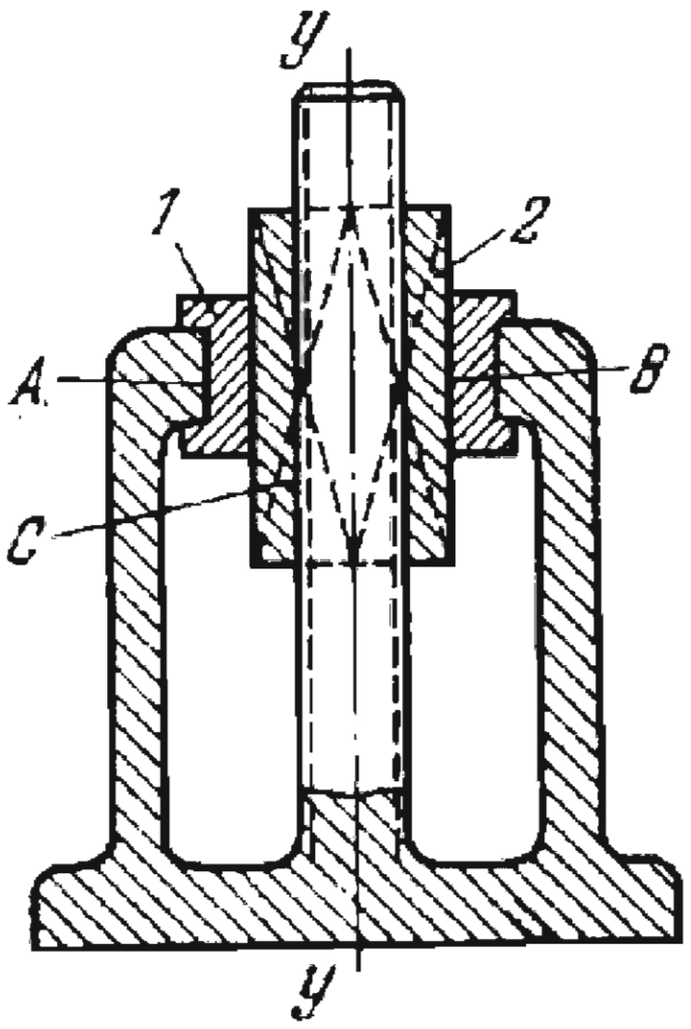
Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. The element of sliding pair *B* belonging to link *2* is designed as a prismatic shank. Screw motion of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = h_A \frac{\varphi_1}{2\pi}$$

where h_A is the pitch of the thread of screw pair *A*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2214 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L



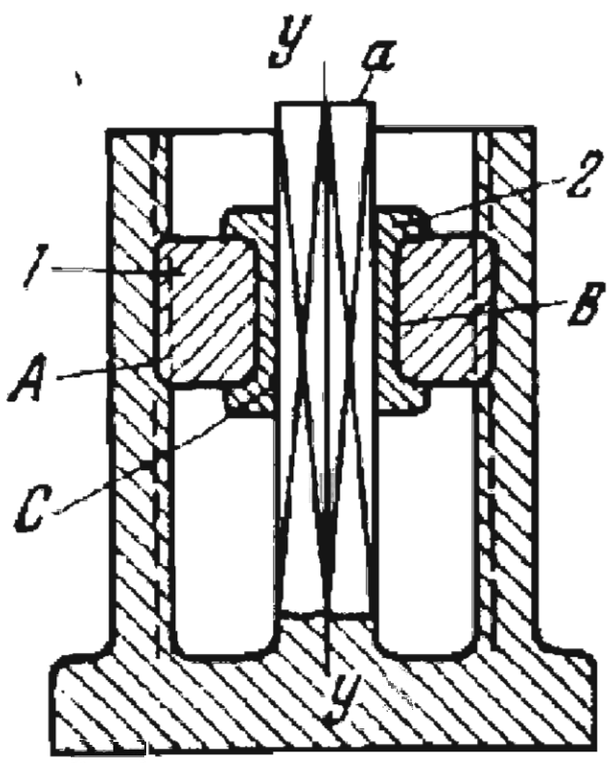
Link *1* is connected by turning pair *A* to the fixed link and by sliding pair *B* to link *2* which, in turn, is connected by screw pair *C* to the fixed link. Link *2* has a prismatic outside surface and internal thread. Rotation of link *1* is converted into screw motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *y*-*y* is

$$s_2 = h_C \frac{\varphi_1}{2\pi}$$

where h_C is the pitch of the thread of screw pair *C*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2215 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L



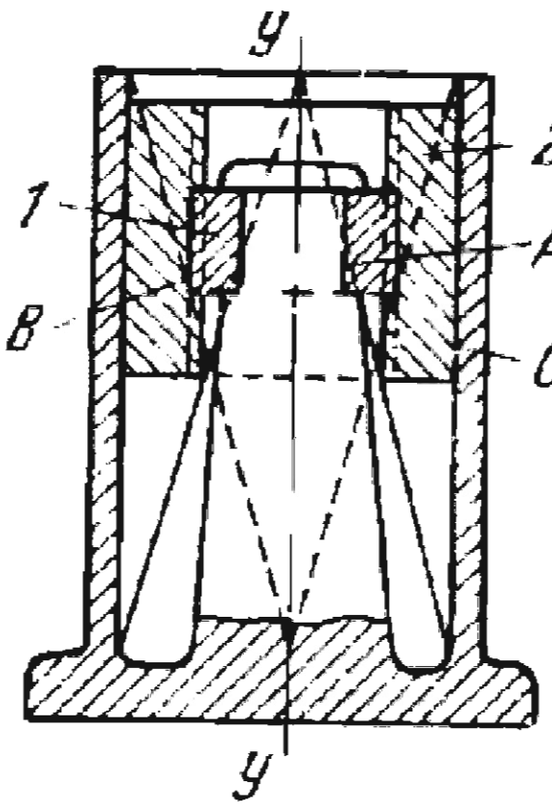
Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *2* has a prismatic hole by means of which it slides along prismatic shank *a* of the fixed link. Screw motion of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *y*-*y* is

$$s_2 = h_A \frac{\varphi_1}{2\pi}$$

where h_A is the pitch of the thread in screw pair *A*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2216 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L



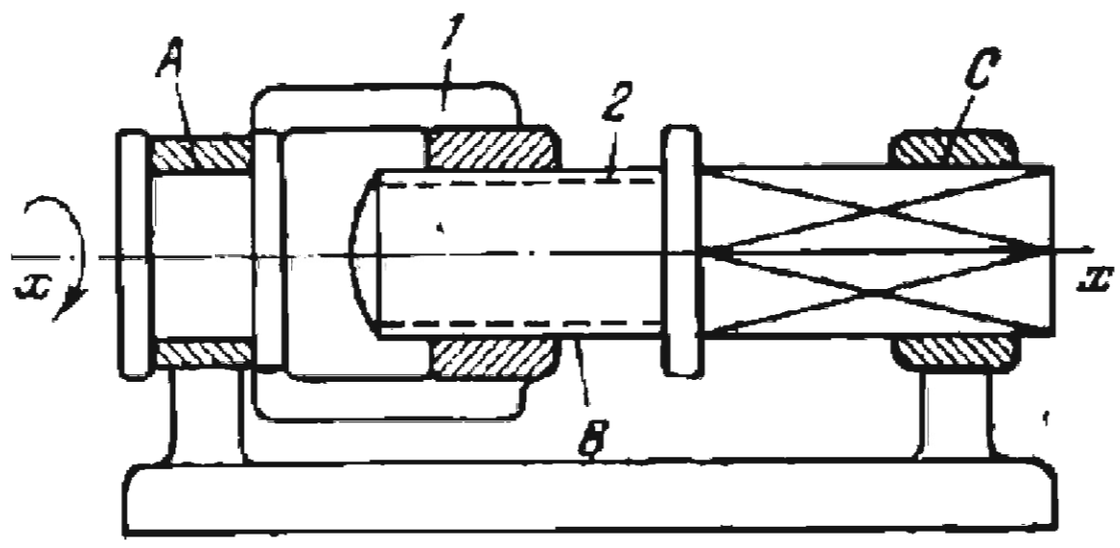
Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *2* is designed as a prismatic slider with internal thread. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *y-y* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2217 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L

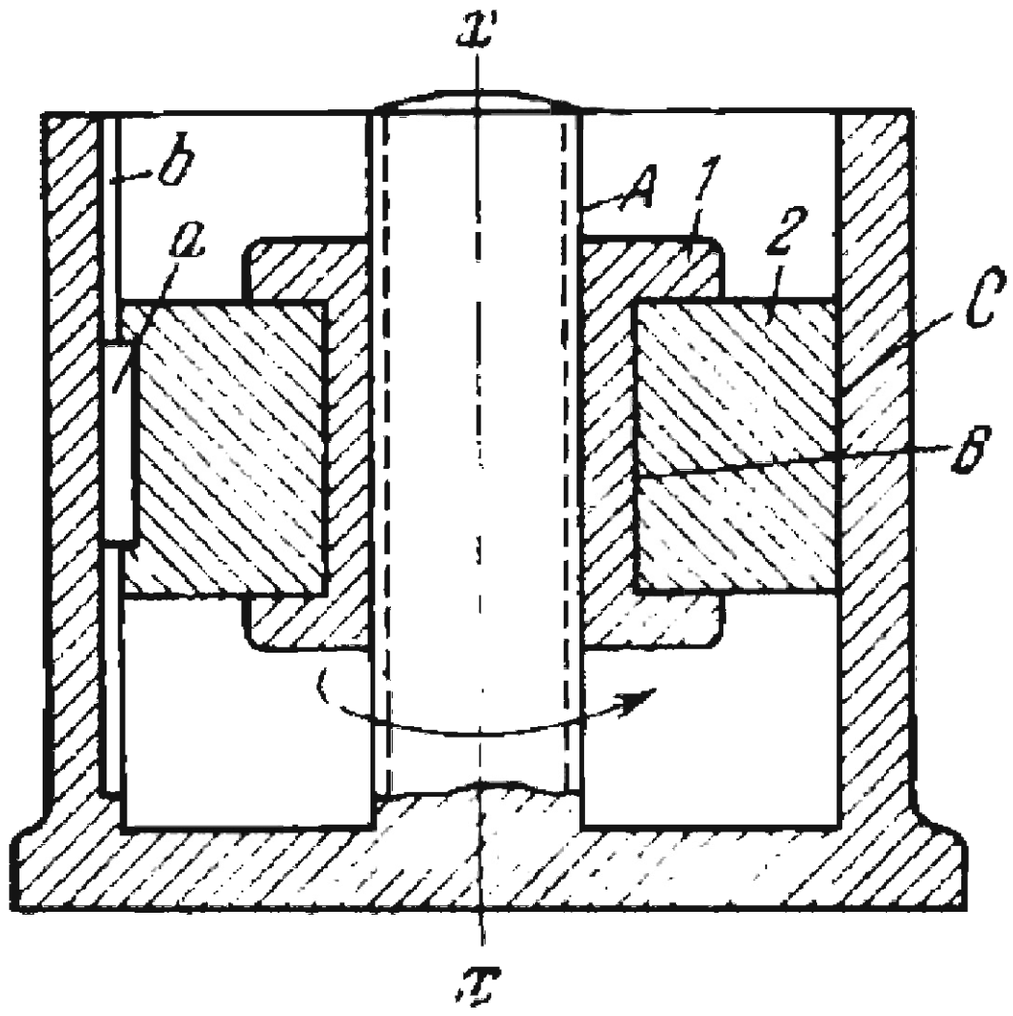


Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *1* has internal and link *2* external screw thread. Rotation of link *1* is converted into sliding motion of link 2. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2218	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

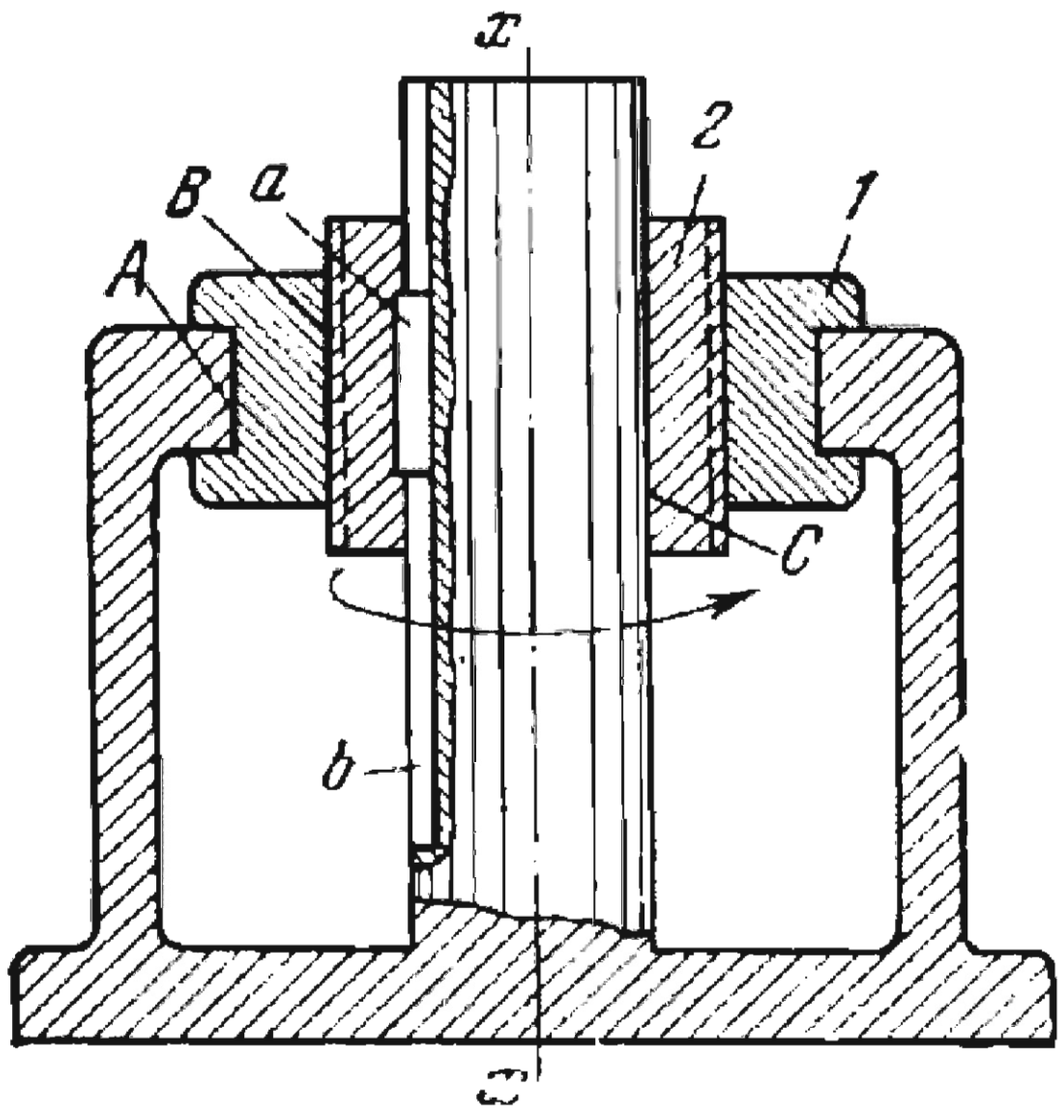


Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. The sliding motion of link *2* is obtained by its feather *a* which enters keyway *b* in the fixed link. Screw motion of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = h_A \frac{\varphi_1}{2\pi}$$

where h_A is the pitch of the thread in screw pair *A*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2219	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

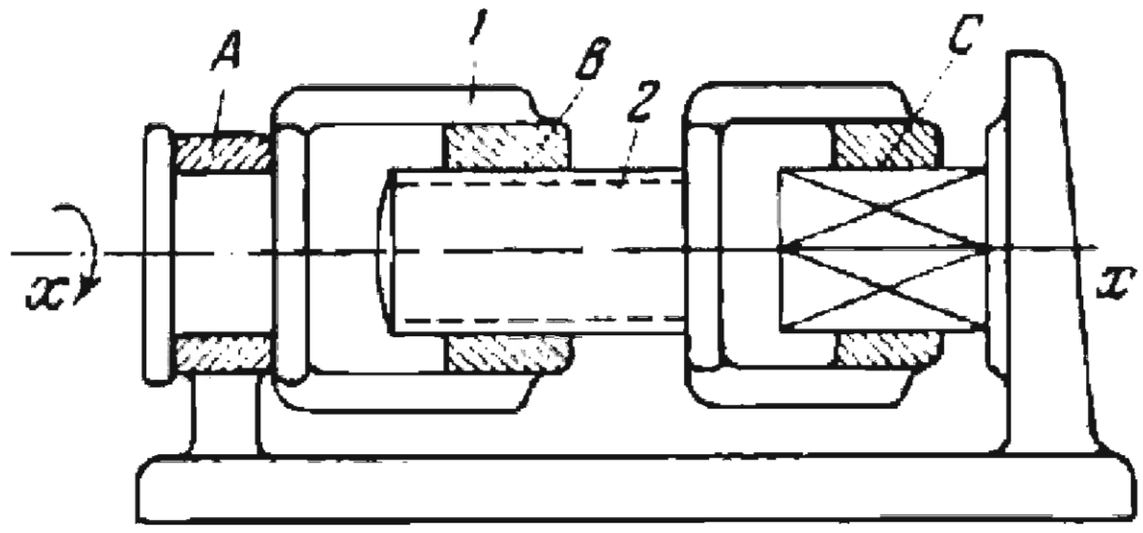


Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. The sliding motion of link *2* is obtained by its feather *a* which enters keyway *b* in the fixed link. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2220	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

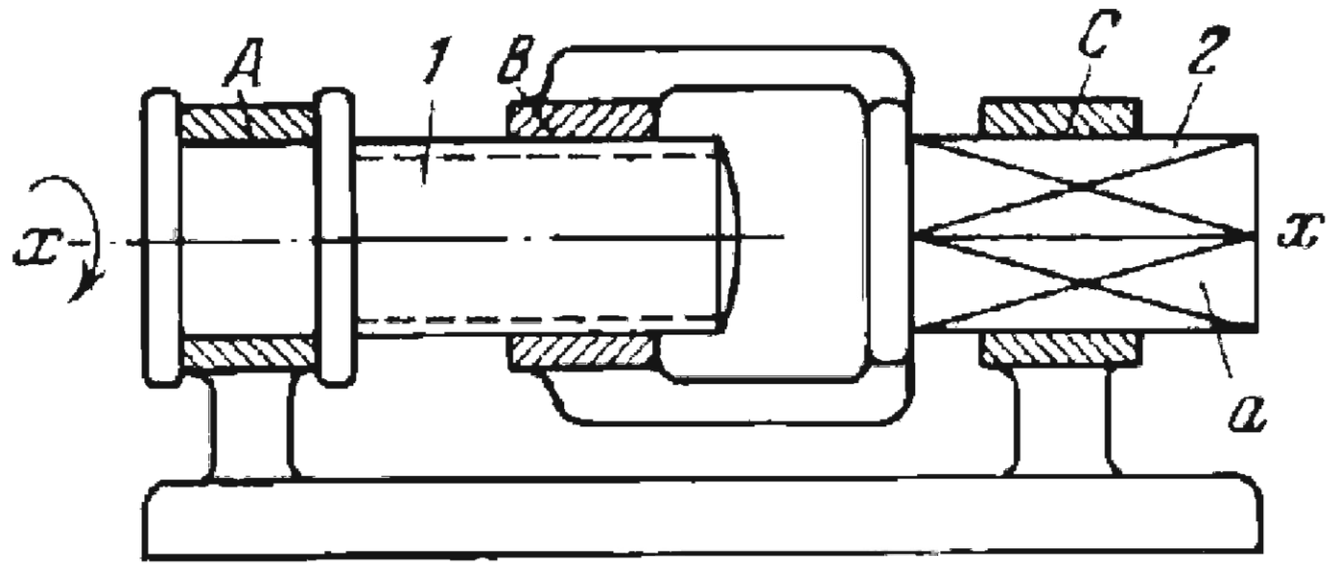


Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *1* has internal and link *2* external screw thread. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread of screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2221	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L



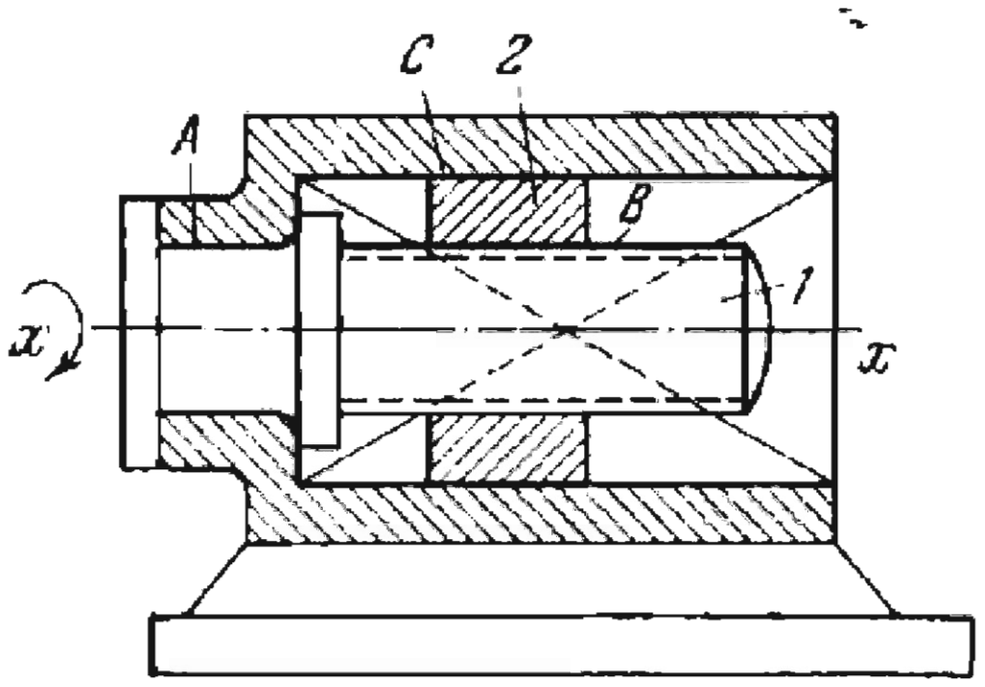
Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. The element of sliding pair *C* belonging to link *2* is designed as prismatic shank *a*. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x-x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread of screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2222 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L



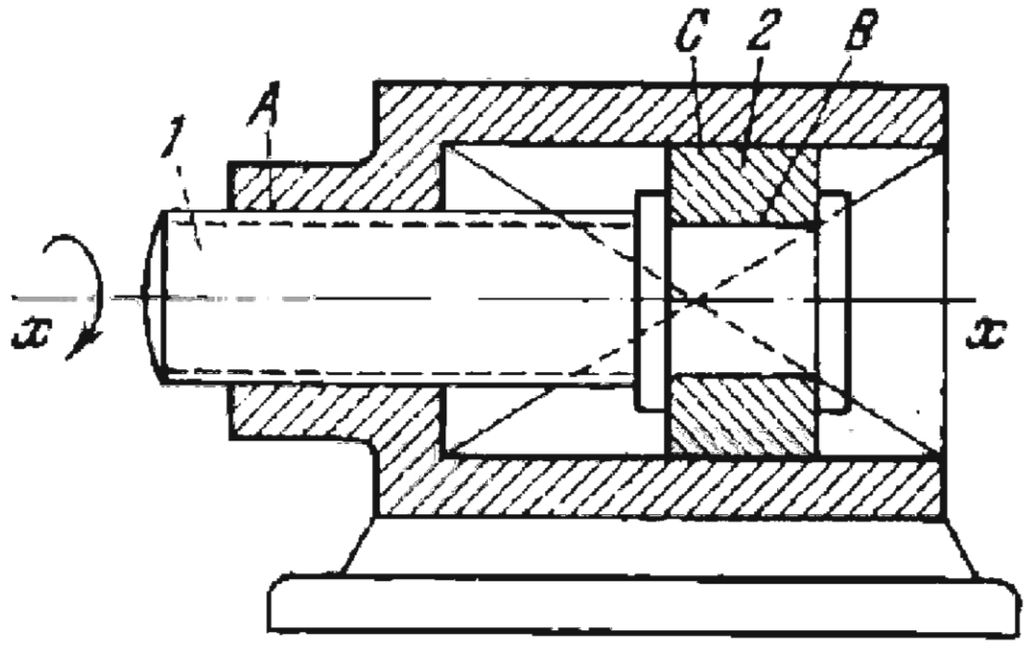
Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *2* is designed as a rectangular block with internal screw thread. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2223 THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS

LS 3L

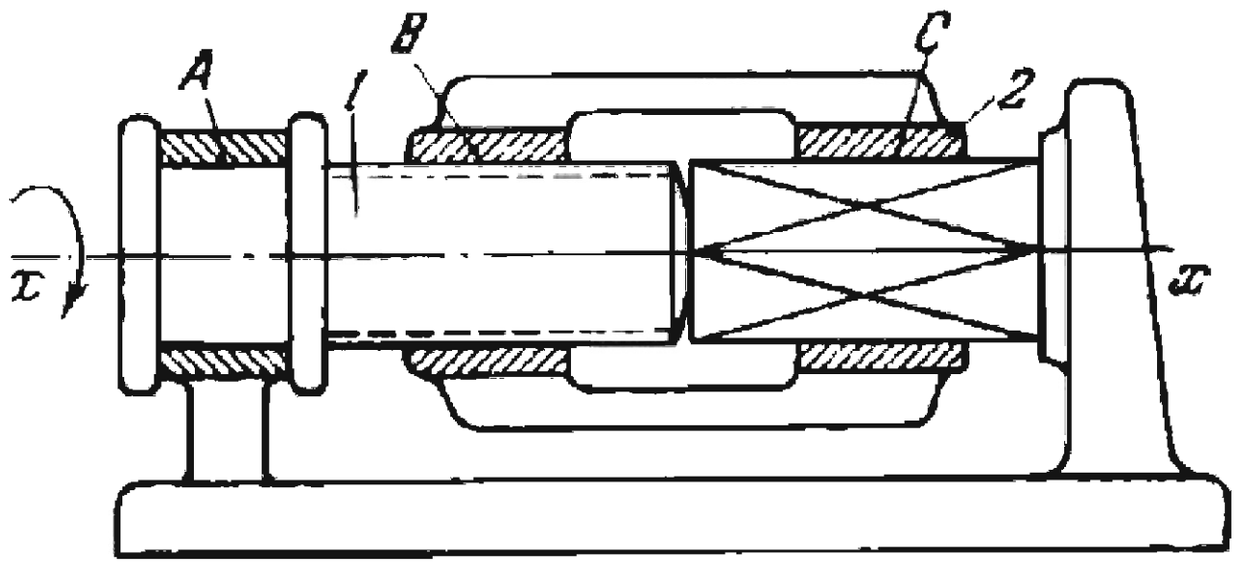


Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *2* is designed as a rectangular block with a round hole. Screw motion of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = h_A \frac{\varphi_1}{2\pi}$$

where h_A is the pitch of the thread in screw pair *A*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

2224	THREE-LINK SCREW-TYPE MECHANISM WITH TURNING AND SLIDING PAIRS	LS 3L

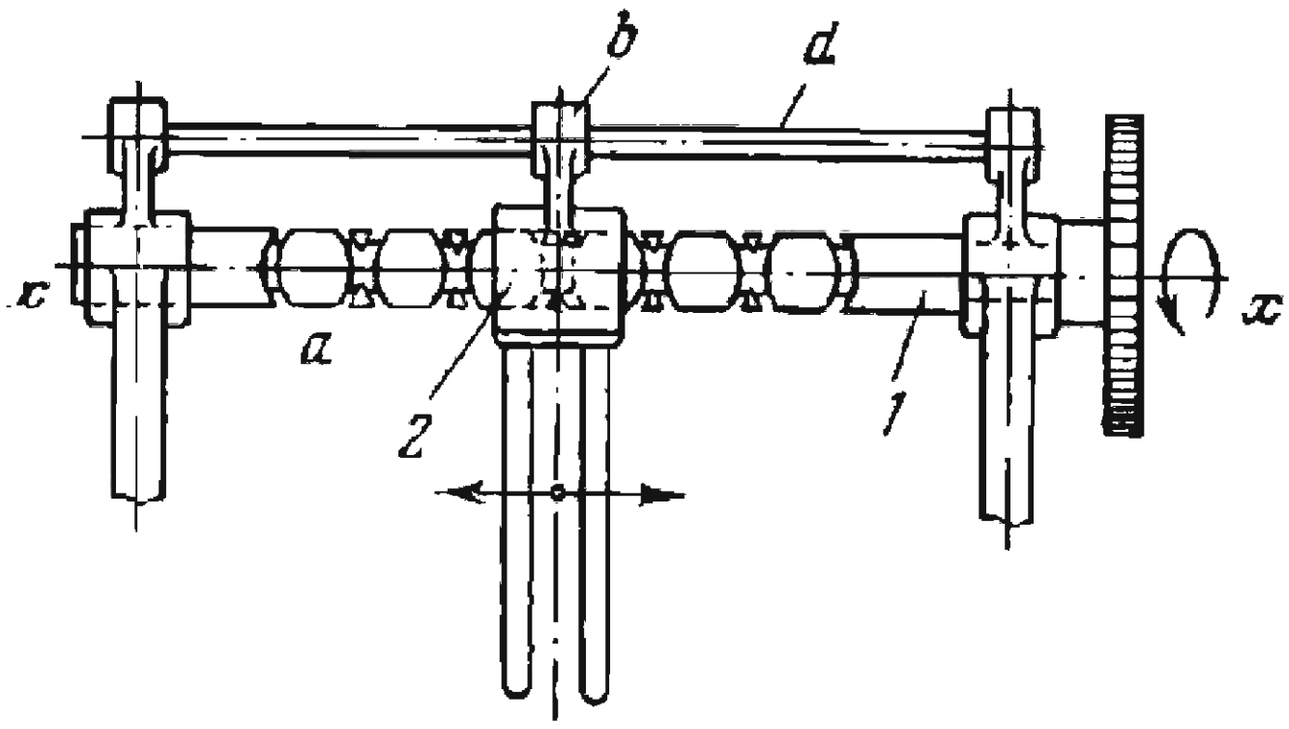


Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *2* which, in turn, is connected by sliding pair *C* to the fixed link. Link *1* has external and link *2* internal screw thread. Rotation of link *1* is converted into sliding motion of link *2*. When link *1* is turned through the angle φ_1, the displacement of link *2* along axis *x*-*x* is

$$s_2 = -h_B \frac{\varphi_1}{2\pi}$$

where h_B is the pitch of the thread in screw pair *B*. It is taken with a plus sign for right-hand thread and with a minus sign for left-hand thread.

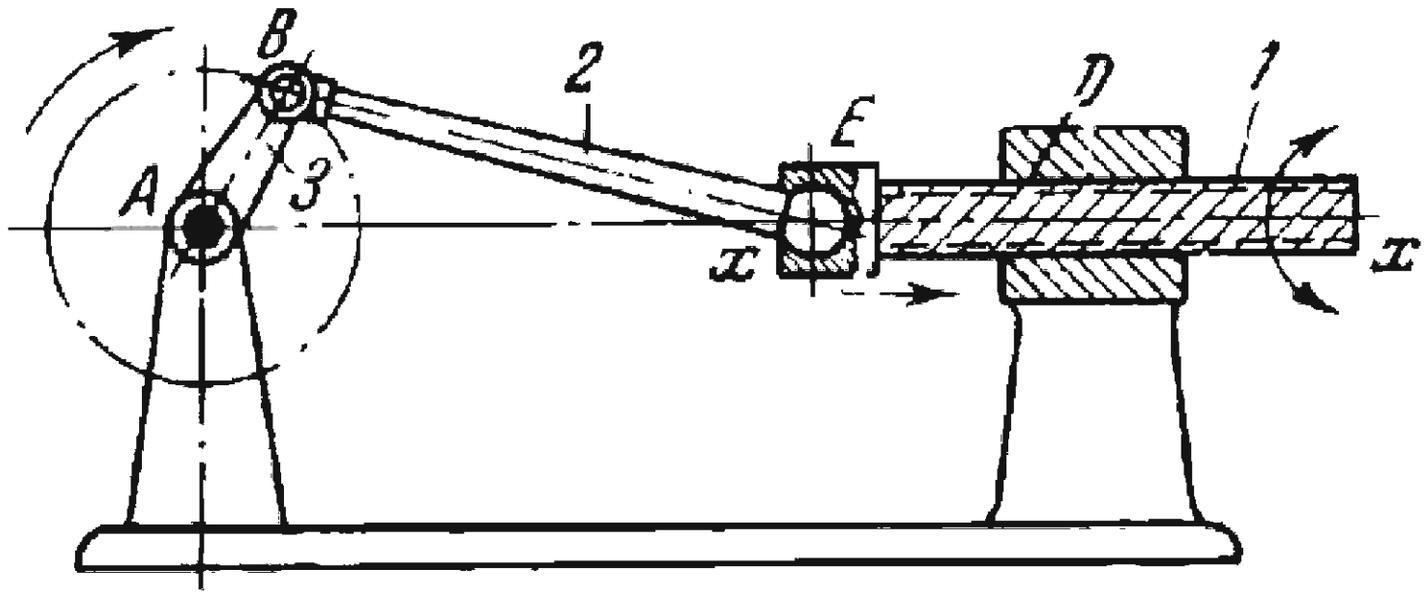
2225	SCREW-TYPE MECHANISM WITH A SELF-INTERSECTING HELICAL RIGHT- AND LEFT-HAND GROOVE	LS 3L



Link *1* rotates about fixed axis *x*-*x* and has a continuous helical groove *a* with a large helix angle and right- and left-hand thread that intersects itself once each pitch. Link *2* has a pin which slides along groove *a* and extension *b* which slides along fixed guide *d*. Continuous rotation of link *1* is converted into continuous reciprocating motion of link *2*.

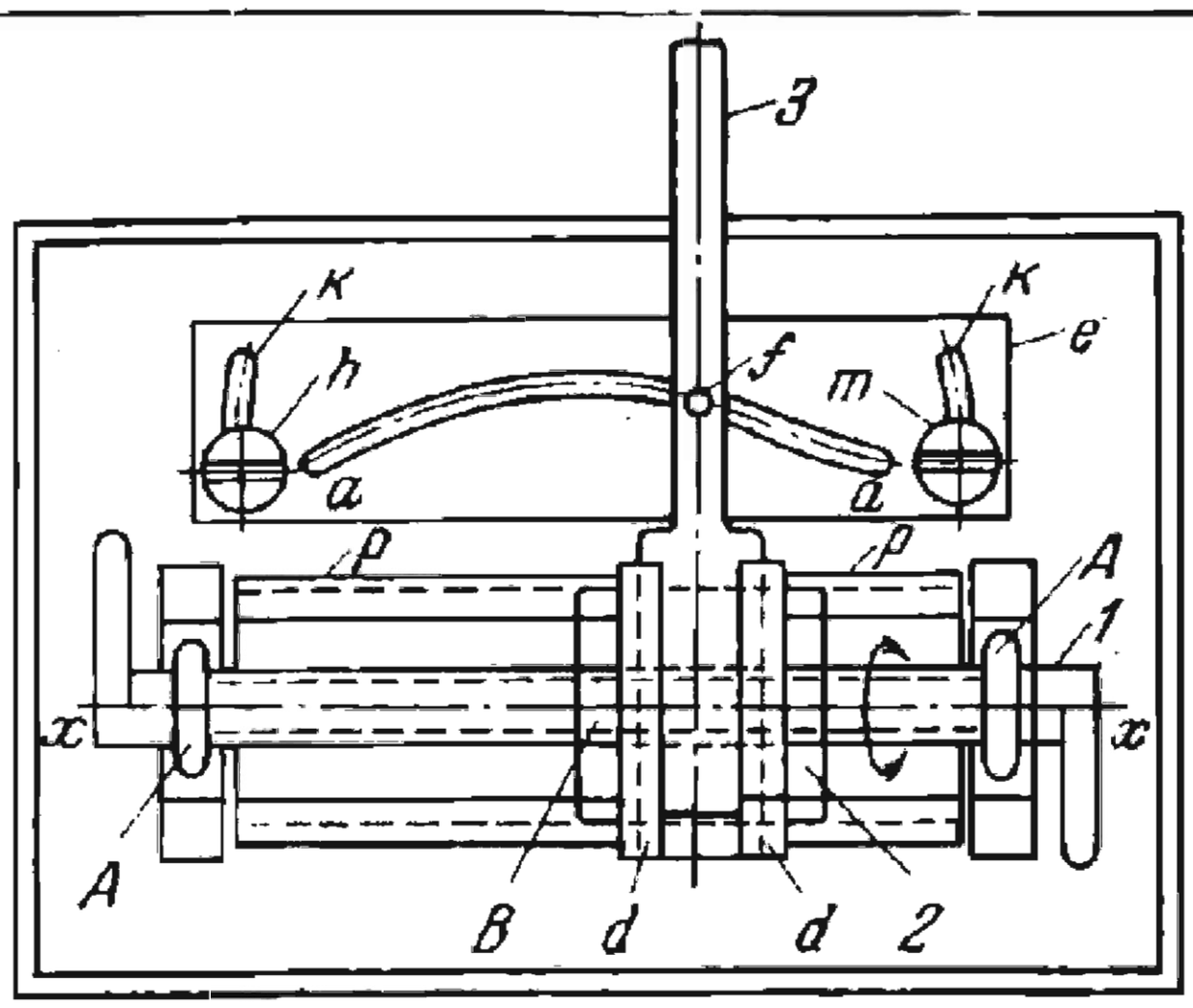
2. GENERAL-PURPOSE FOUR-LINK MECHANISMS
(2226, 2227 and 2228)

2226	FOUR-LINK LEVER-SCREW MECHANISM	LS 4L



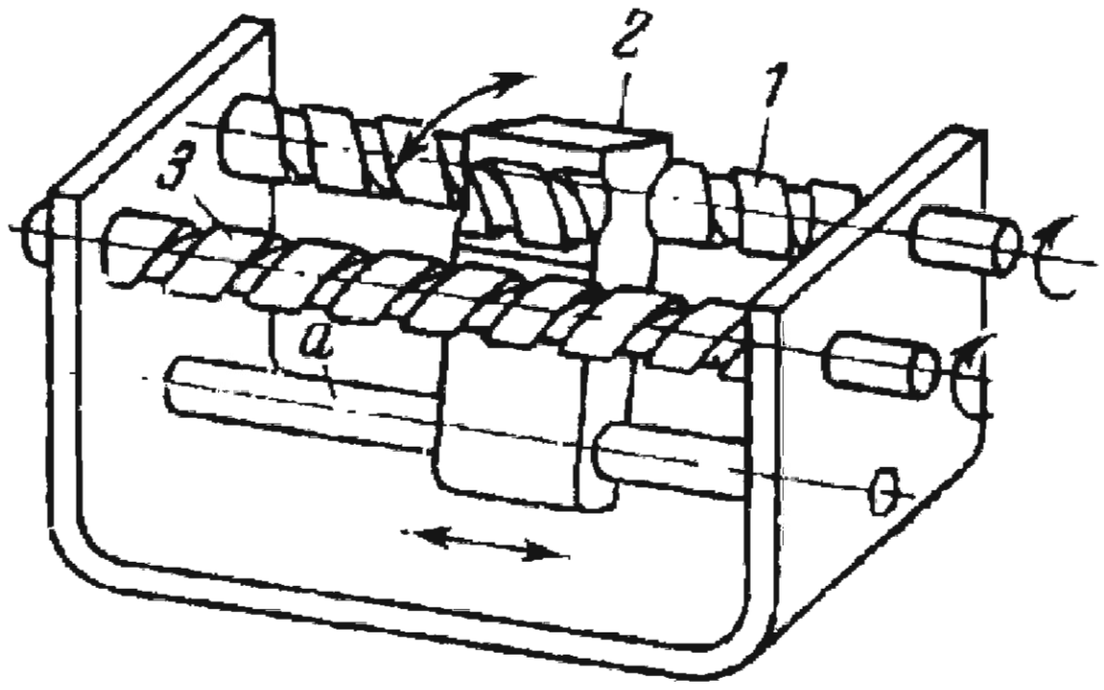
Link *1* is connected by screw pair *D* to the fixed link and by spherical pair *E* to link *2* which, in turn, is connected by turning pair *B* to crank *3*, rotating about fixed axis *A*. Rotation of crank *3* about axis *A* is converted into rotation of link *1* about axis *x-x*. If crank *3* is the driving link, the helix angle of the thread on link *1* should be greater than the angle of friction.

2227	LEVER-SCREW MECHANISM OF A BAR WITH A VARIABLE STROKE	LS 4L



Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to slider *2* which moves along fixed guides *p-p*. Link *2* has guides *d-d* along which bar *3* slides. Bar *3* carries pin *f* which slides along slot *a-a*. When link *1* is rotated, slider *2*, together with bar *3*, moves along axis *x-x* of link *1*. Owing to slot *a-a* in plate *e*, bar *3* has a sliding motion perpendicular to the axis of link *1*. The law of motion of bar *3* can be varied by adjusting plate *e* and clamping it with screws *h* and *m* in various positions.

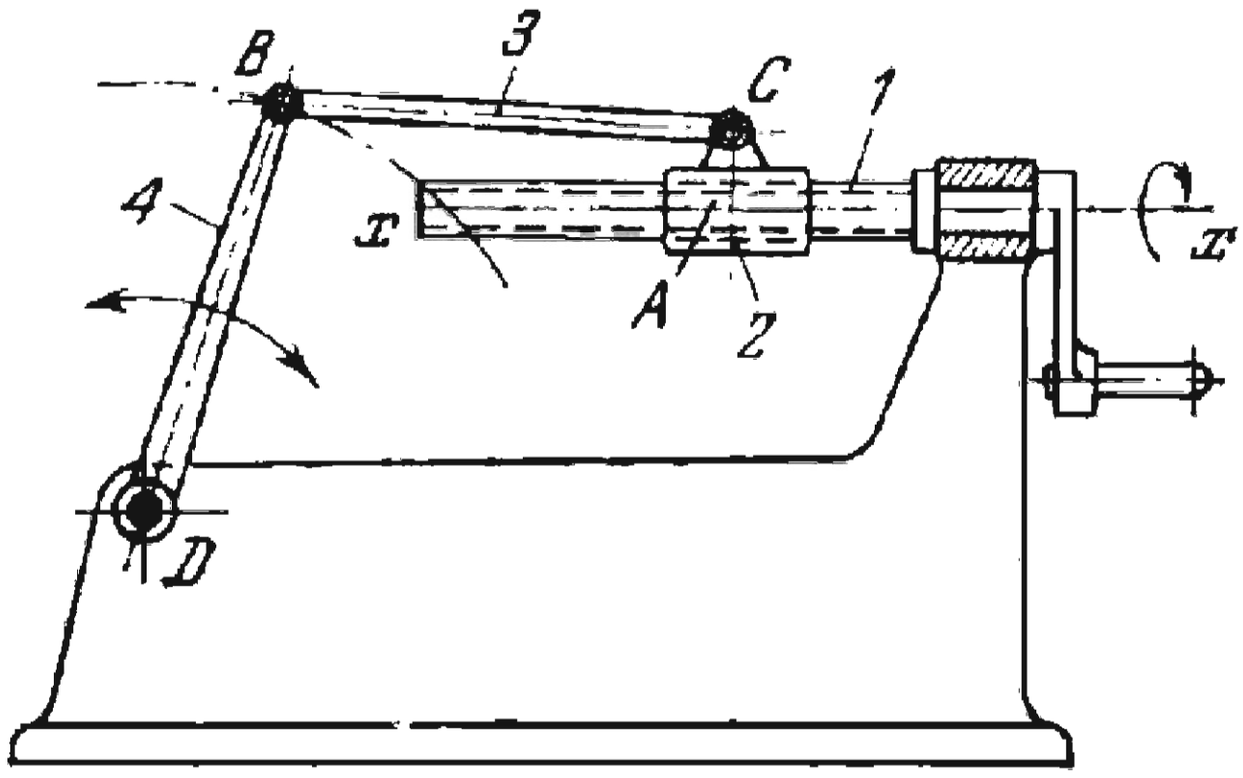
2228	SCREW-TYPE MECHANISM WITH TUMBLER HALF-NUTS	LS 4L



Half-nut link *2* slides along fixed guide *a* and can be turned about the axis of the guide so that its half-nuts engage screw *1* or screw *3*. When the corresponding half-nut of link *2* is engaged to screw *1* having right-hand thread, link *2* slides in one direction along guide *a*. This direction can be reversed by disengaging link *2* from link *1* and bringing the other half-nut into engagement with screw *3* having left-hand thread and rotating in the same direction as screw *1*.

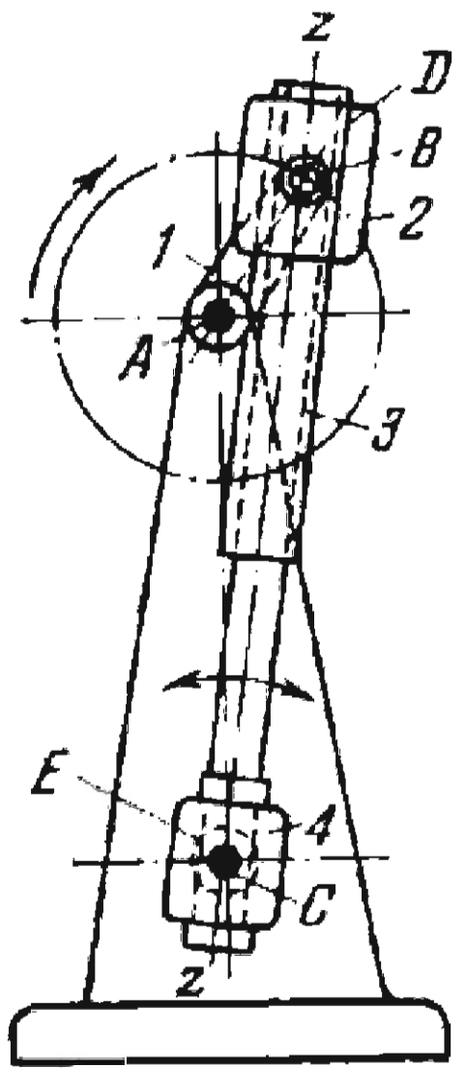
3. GENERAL-PURPOSE FIVE-LINK MECHANISMS
(2229 through 2237)

2229	FIVE-LINK LEVER-SCREW MECHANISM	LS 5L



Link *1* rotates about fixed axis *x-x* and is connected by screw pair *A* to link *2*. Link *3* is connected by turning pairs *C* and *B* to links *2* and *4*. Link *4* turns about fixed axis *D*. Link *4* is turned by rotating link *1* about axis *x-x*.

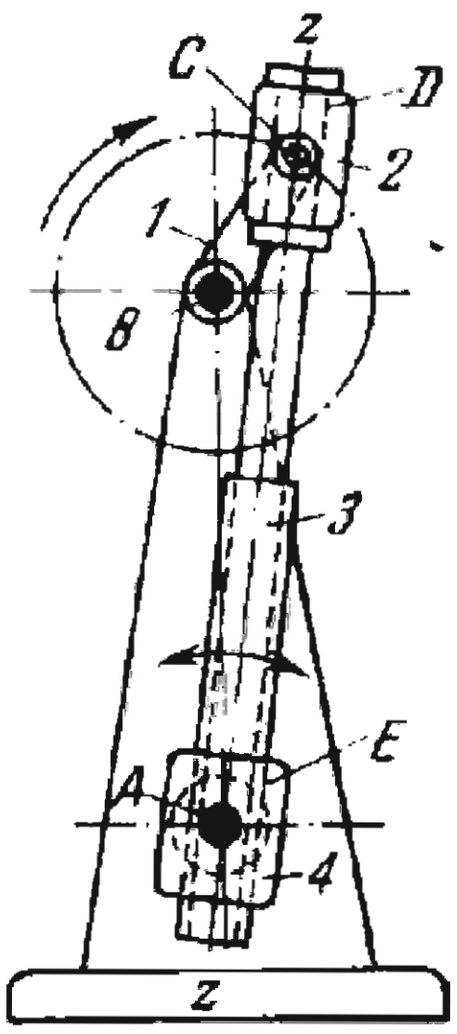
2230	FIVE-LINK LEVER-SCREW MECHANISM	LS 5L



Crank *1* rotates about fixed axis *A* and is connected by turning pair *B* to link *2* which, in turn, is connected by screw pair *D* to link *3*. Link *3* is connected by turning pair *E* to link *4* which turns about fixed axis *C*. The helix angle of the thread of screw pair *D* is greater than the angle of friction. When crank *1* rotates about axis *A*, link *3* oscillates about axis *C* and about its own axis *z-z*.

2231 FIVE-LINK LEVER-SCREW MECHANISM

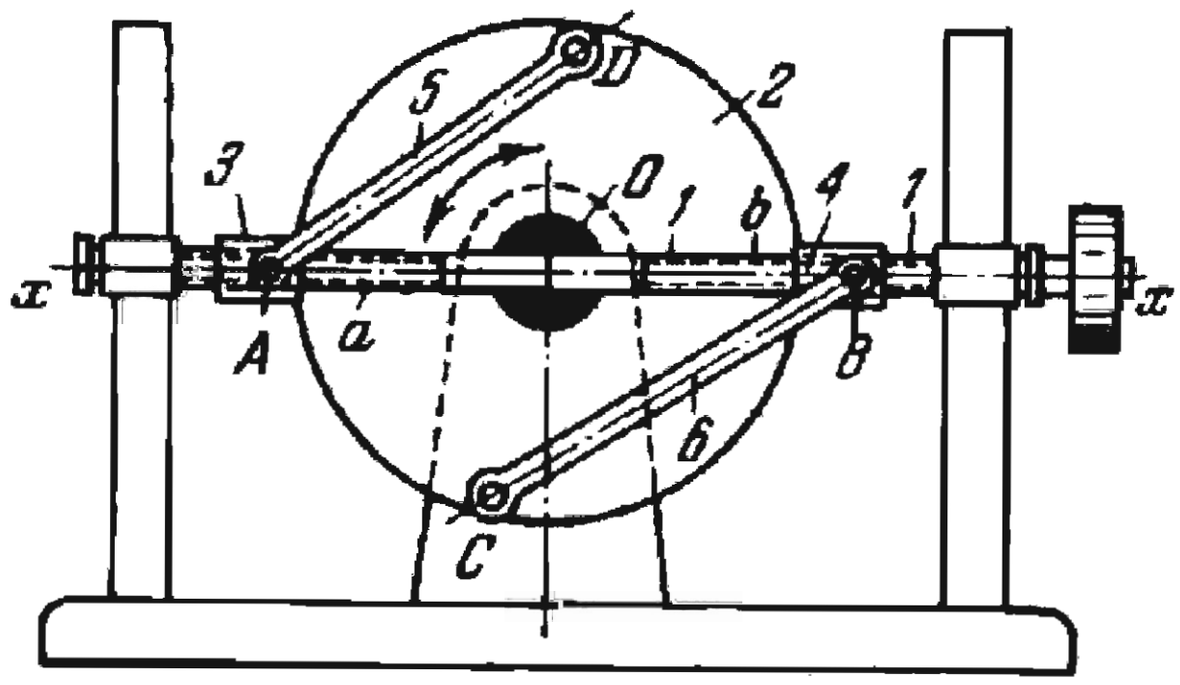
LS
5L



Crank *1* rotates about fixed axis *B* and is connected by turning pair *C* to link *2* which, in turn, is connected by turning pair *D* to link *3*. Link *3* is connected by screw pair *E* to link *4* which turns about fixed axis *A*. The helix angle of the thread of screw pair *E* is greater than the angle of friction. When crank *1* rotates about axis *B*, link *3* oscillates about axis *A* and about its own axis *z*-*z*.

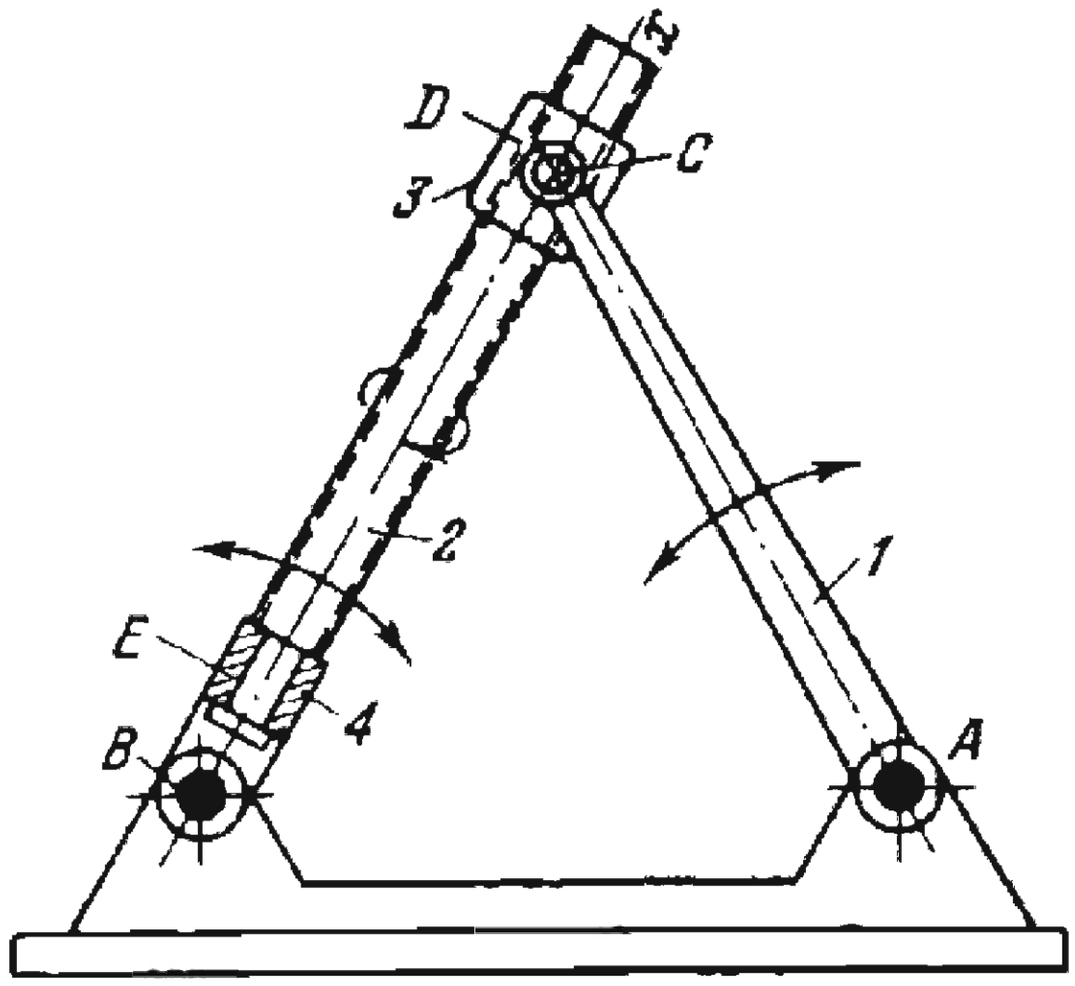
2232 LEVER-SCREW DISK ROTATION MECHANISM

LS
5L



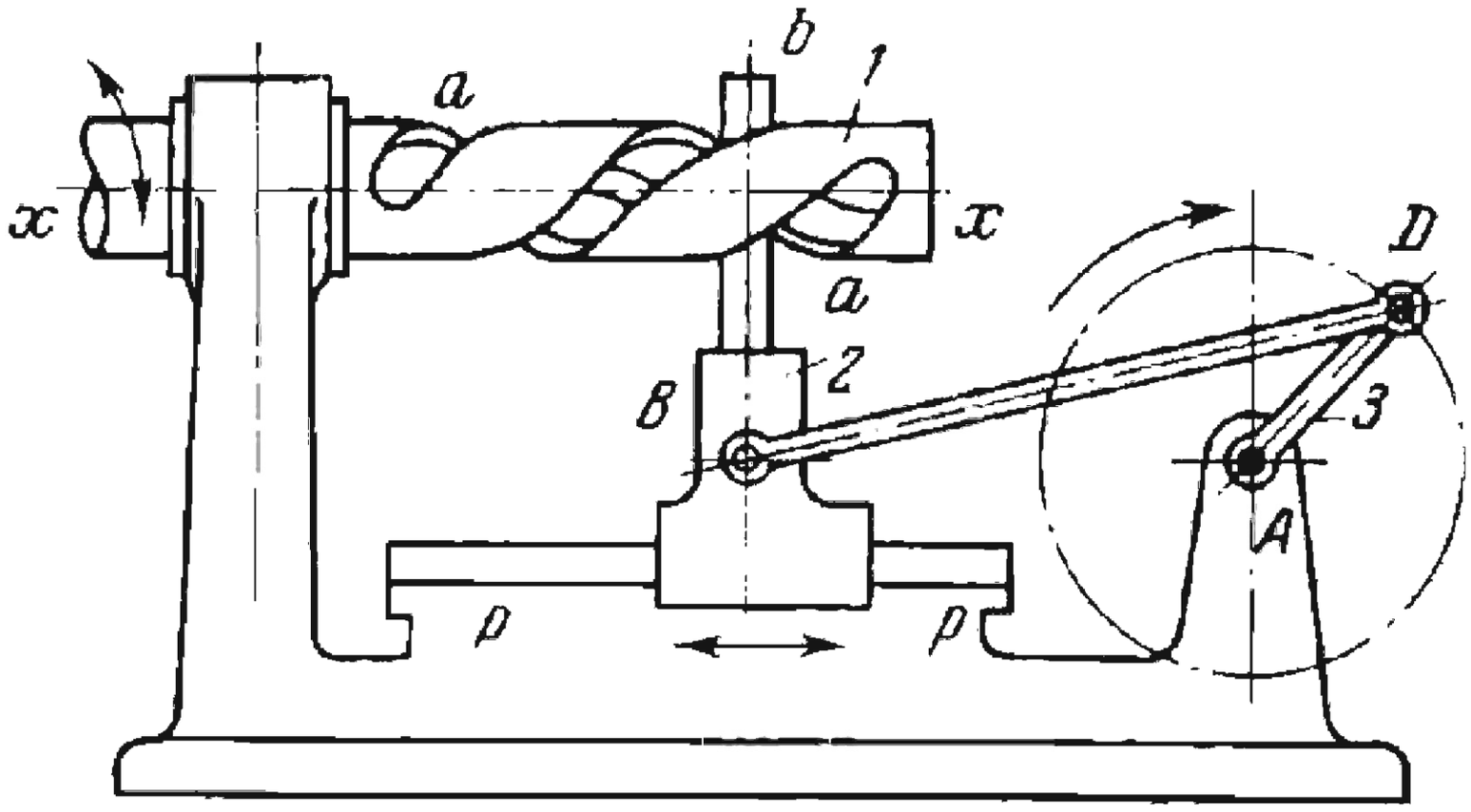
The lengths of the links comply with the conditions: $\overline{AD} = \overline{CB}$ and $\overline{OD} = \overline{OC}$. Link *1* rotates about fixed axis *x*-*x* and is connected by screw pairs to links *3* and *4*. Links *3* and *4* are connected by turning pairs *A* and *B* to links *5* and *6* which, in turn, are connected by turning pairs *D* and *C* to disk *2*. Disk *2* turns about fixed axis *O*. Screw *1* has right-hand and left-hand threads, *a* and *b*, of equal pitch. As a result, when screw *1* is rotated, disk *2* turns about axis *O*.

2233	FIVE-LINK LEVER-SCREW MECHANISM	LS 5L



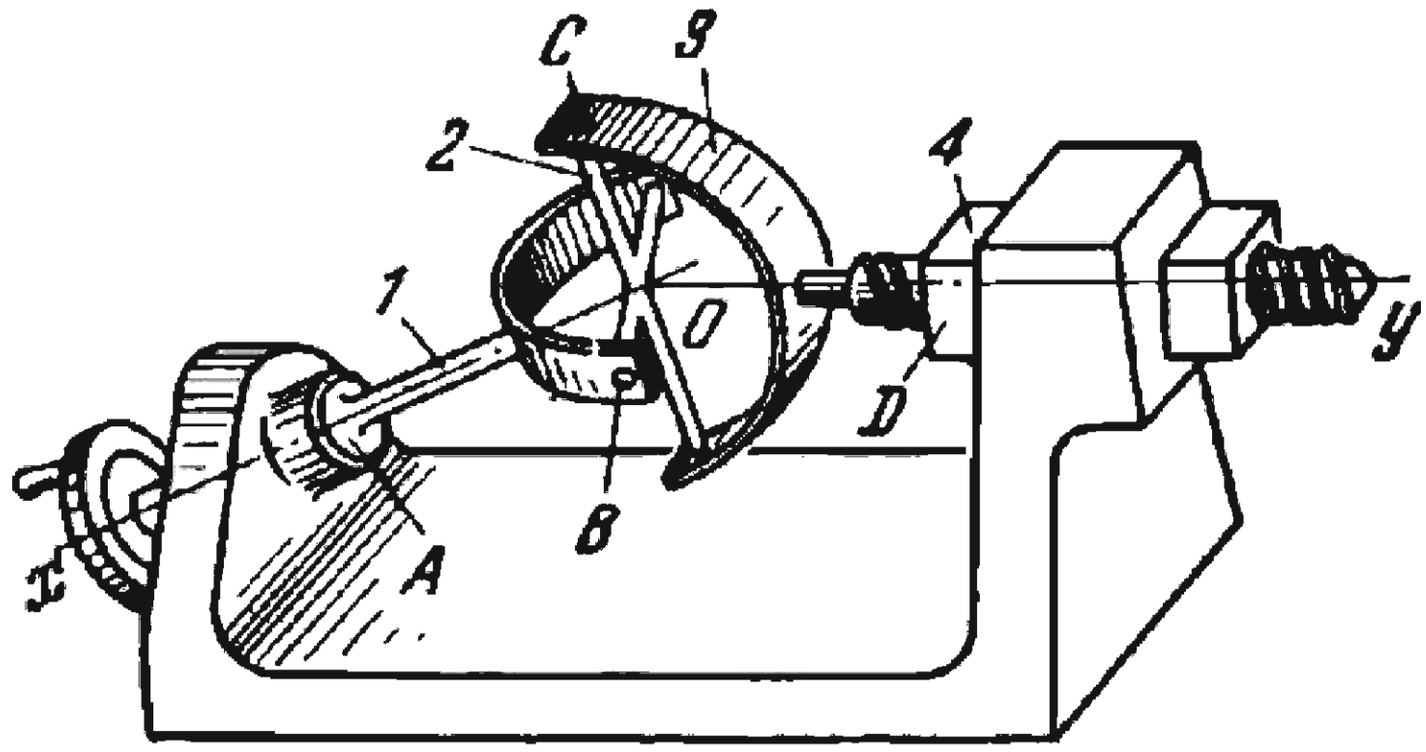
Link *1* turns about fixed axis *A* and is connected by turning pair *C* to link *3* which, in turn, is connected by screw pair *D* to link *2*. Link *2* is connected by turning pair *E* to link *4* which turns about fixed axis *B*. When link *1* turns about axis *A*, link *2* simultaneously turns about its axis *x* and about axis *B*.

2234	LEVER-SCREW MECHANISM WITH A SLIDER-CRANK DRIVE	LS 5L



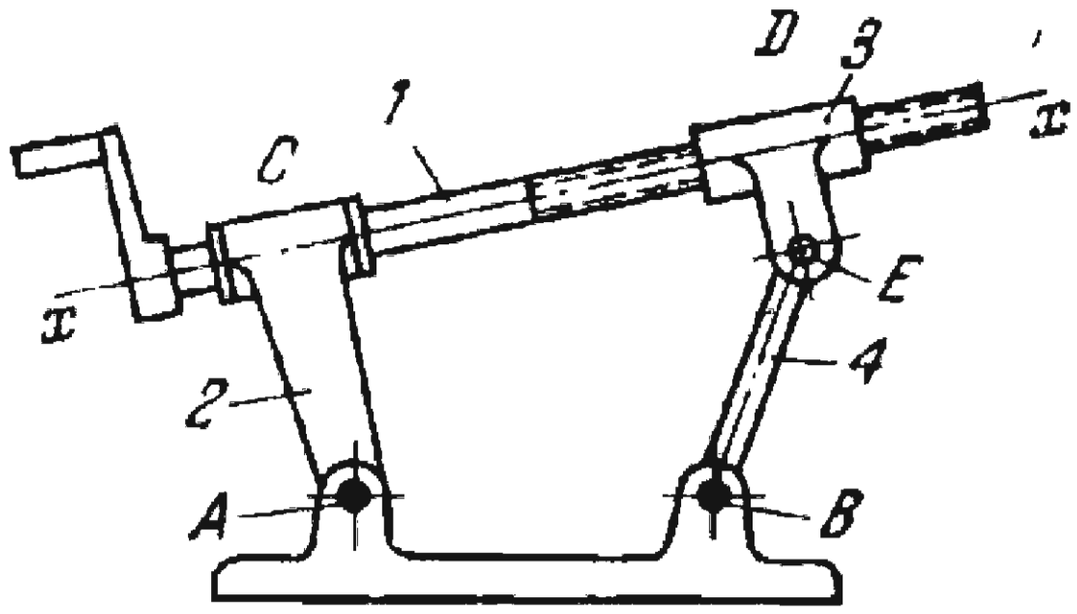
Slider *2* of slider-crank linkage *ADB* moves along fixed guides *p-p* and has pin *b* which slides along the helical slots of link *1*. Link *1* turns about fixed axis *x-x*. When crank *3* rotates about fixed axis *A*, link *1* rotates first in one direction and then in the other.

2235	LEVER-SCREW SPATIAL MECHANISM	LS 6L



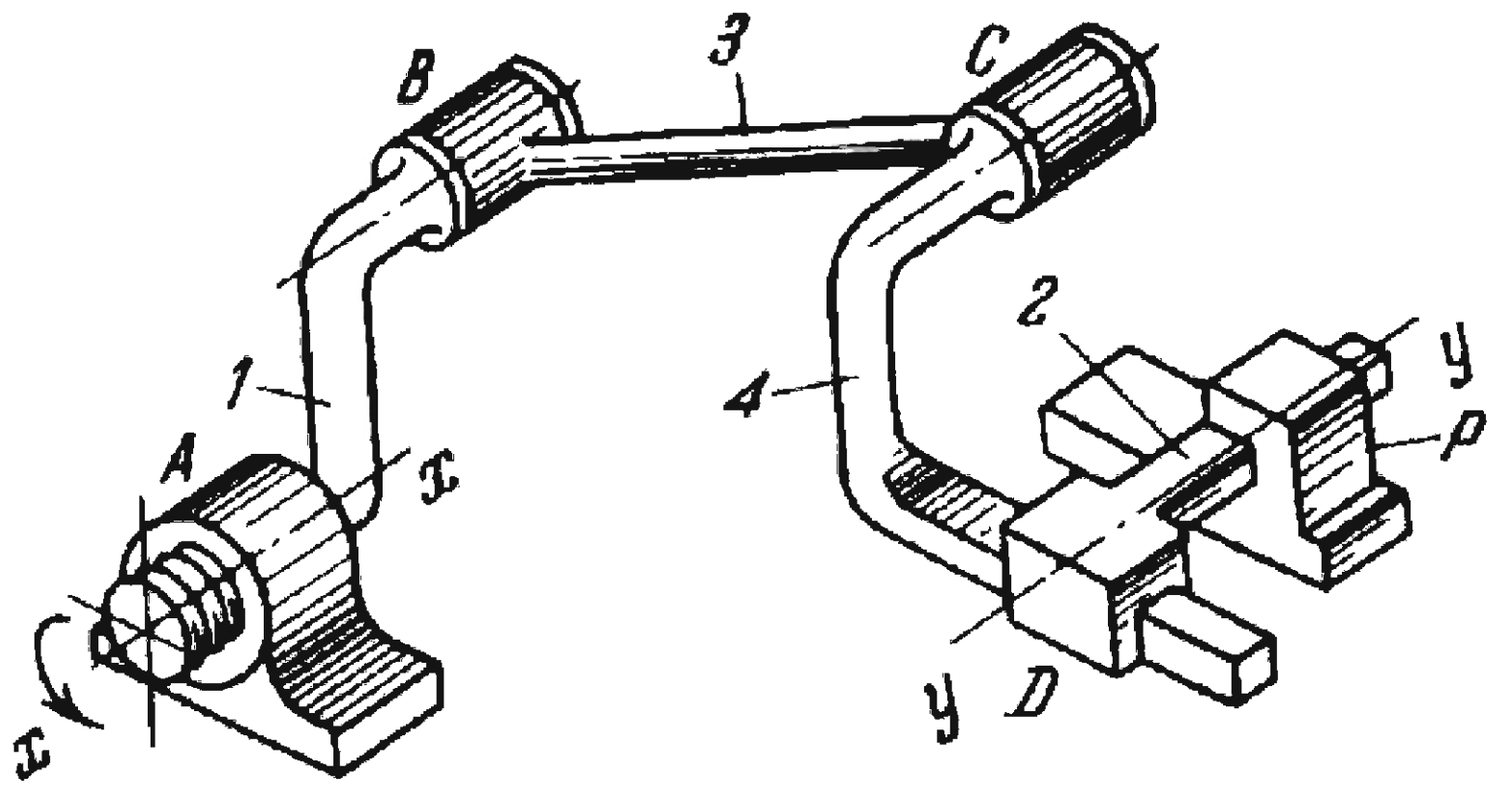
Link *1* is connected by turning pair *A* to the fixed link and by turning pair *B* to cross-shaped link *2*. Link *2* is connected by turning pair *C* to link *3* which, in turn, is connected by screw pair *D* to slider *4*. Slider *4* moves in fixed guides. The axes of turning pairs *A*, *B*, and *C*, and of screw pair *D* should intersect at a single point *O*. Rotation of link *1* about axis *Ox* is converted into sliding motion of link *4* along axis *Oy*.

2236	LEVER-SCREW SPATIAL MECHANISM	LS 5L



Link *2* turns about fixed axis *A* and is connected by turning pair *C* to link *1* which, in turn, is connected by screw pair *D* to link *3*. Link *3* is connected by turning pair *E* to link *4* which turns about fixed axis *B*. When link *1* is rotated about axis *x-x*, links *2* and *4* turn about axes *A* and *B*.

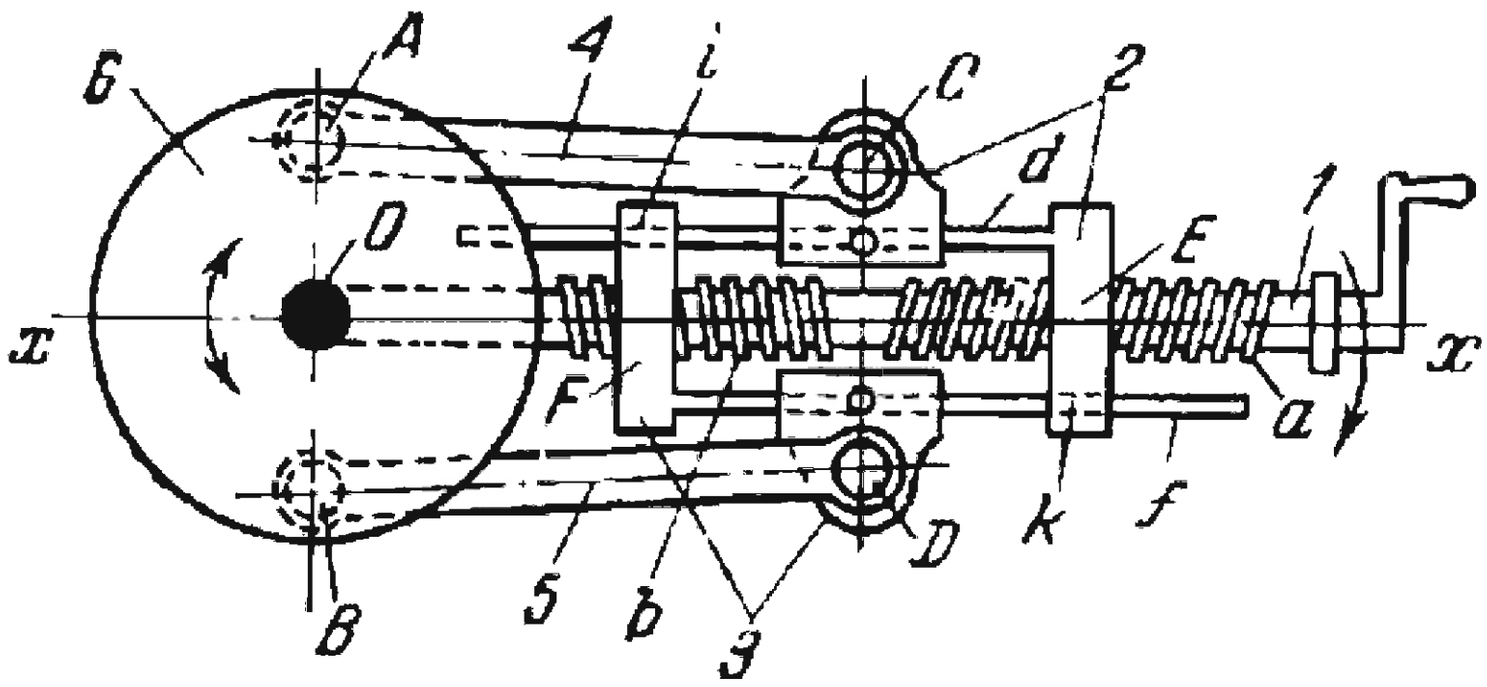
2237	LEVER-SCREW SPATIAL MECHANISM	LS 5L



Link *1* is connected by screw pair *A* to the fixed link and by turning pair *B* to link *3* which, in turn, is connected by turning pair *C* to link *4*. Link *4* is connected by sliding pair *D* to link *2* which slides in fixed guide *p*. Screw motion of link *1* about and along axis *x-x* is converted into sliding motion of link *2* along axis *y-y* which is parallel to axis *x-x*. The axes of pairs *B* and *C* are also parallel to axes *x-x* and *y-y*.

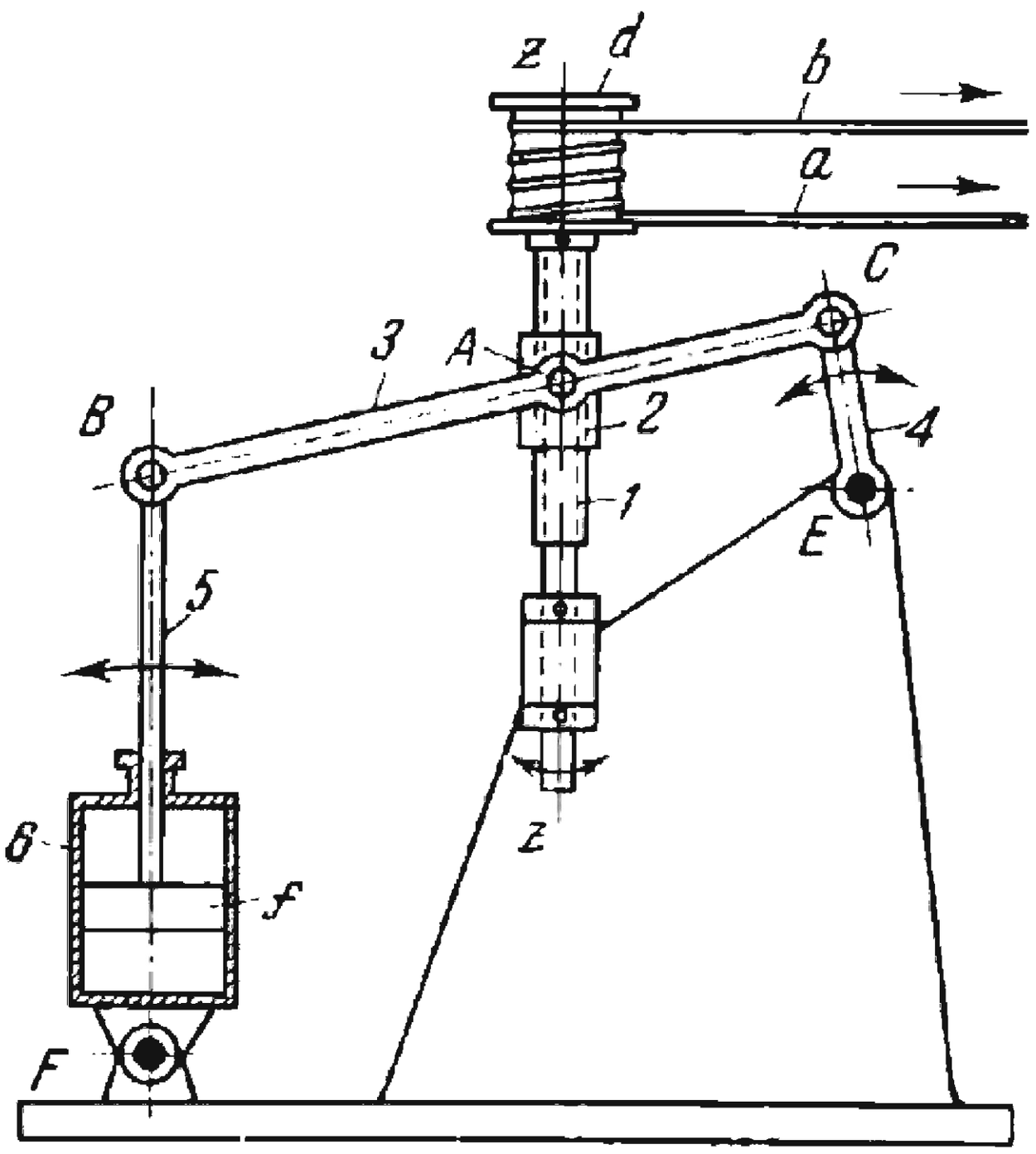
4. GENERAL-PURPOSE MULTIPLE-LINK MECHANISMS
(2238, 2239 and 2240)

2238	SCREW-TYPE MECHANISM OF A ROTARY DISK	LS ML



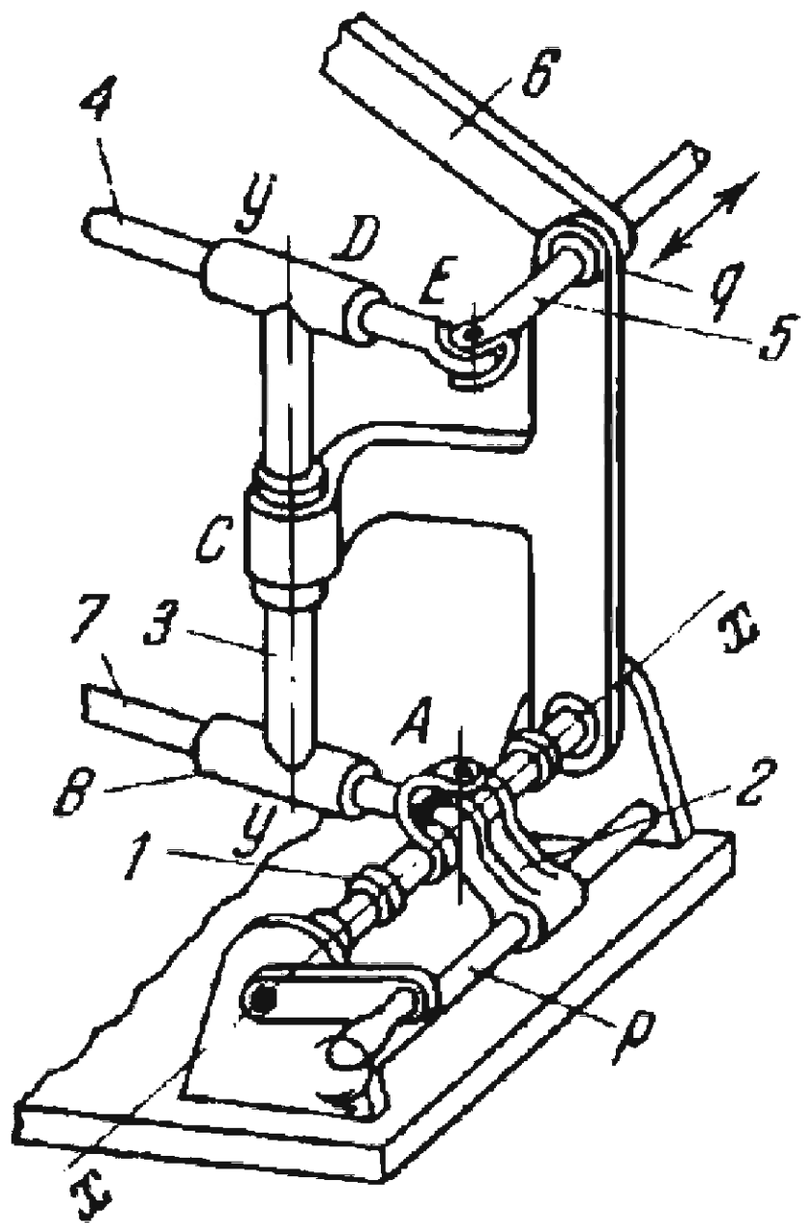
Link *1* rotates about axis *x-x* and is connected by screw pairs *E* and *F* to links *2* and *3* which, in turn, are connected by turning pairs *C* and *D* to links *4* and *5*. Links *4* and *5* are of equal length and are connected by turning pairs *A* and *B* to disk *6* which turns about fixed axis *O*. Link *1* has right- and left-hand screw threads, *a* and *b*. Rods *d* and *f* of links *2* and *3* slide in the corresponding holes *i* and *k* of these links. When link *1* is rotated, links *2* and *3* move in opposite directions and, through links *4* and *5*, rotate disk *6* through a certain angle about axis *O*.

2239	LEVER-SCREW OSCILLATING CYLINDER MECHANISM WITH A FLEXIBLE LINK	LS ML



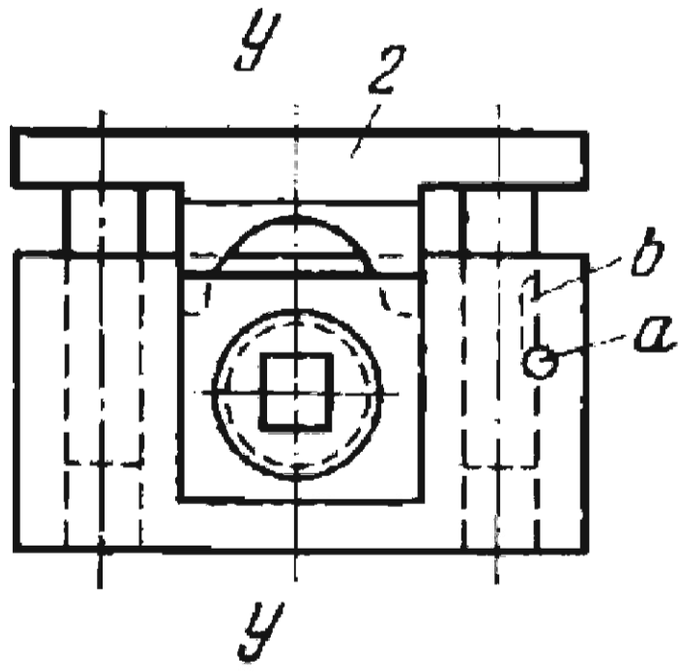
Link *1* rotates about fixed axis *z-z* and is connected by a screw pair to link *2*. Link *1* has pulley *d* on which a rope is wound. When branch *a* of the rope is pulled, link *2* moves downward; when branch *b* is pulled, it moves upward. Link *2* is connected by turning pair *A* to link *3* which, in turn, is connected by turning pairs *B* and *C* to links *5* and *4*. Link *4* turns about fixed axis *E*. Link *5* has piston *f* sliding in cylinder *6* which turns about fixed axis *F*. When branches *a* and *b* of the rope are alternately pulled, piston *f* reciprocates in cylinder *6*.

2240	LEVER-SCREW SPATIAL MECHANISM	LS ML



Link *1* rotates about fixed axis *x-x* and is connected by a screw pair to link *2* which slides along fixed guide *p*. Link *2* is connected by turning pair *A* to link *7* which, in turn, is connected by sliding pair *B* to link *3*. Link *3* turns about fixed axis *y-y* and is connected by turning pair *C* to the fixed link and by sliding pair *D* to link *4*. Link *4* is connected by turning pair *E* to link *5* which slides in fixed guide *q*. The axes of turning pairs *A*, *C* and *E* are parallel to one another. The axes of sliding pairs *B* and *D*, of guides *p* and *q* and axis *x-x* are parallel to a common plane and perpendicular to axis *y-y*. When link *1* is rotated about axis *x-x*, link *6*, rigidly attached to link *5*, slides in guide *q*.

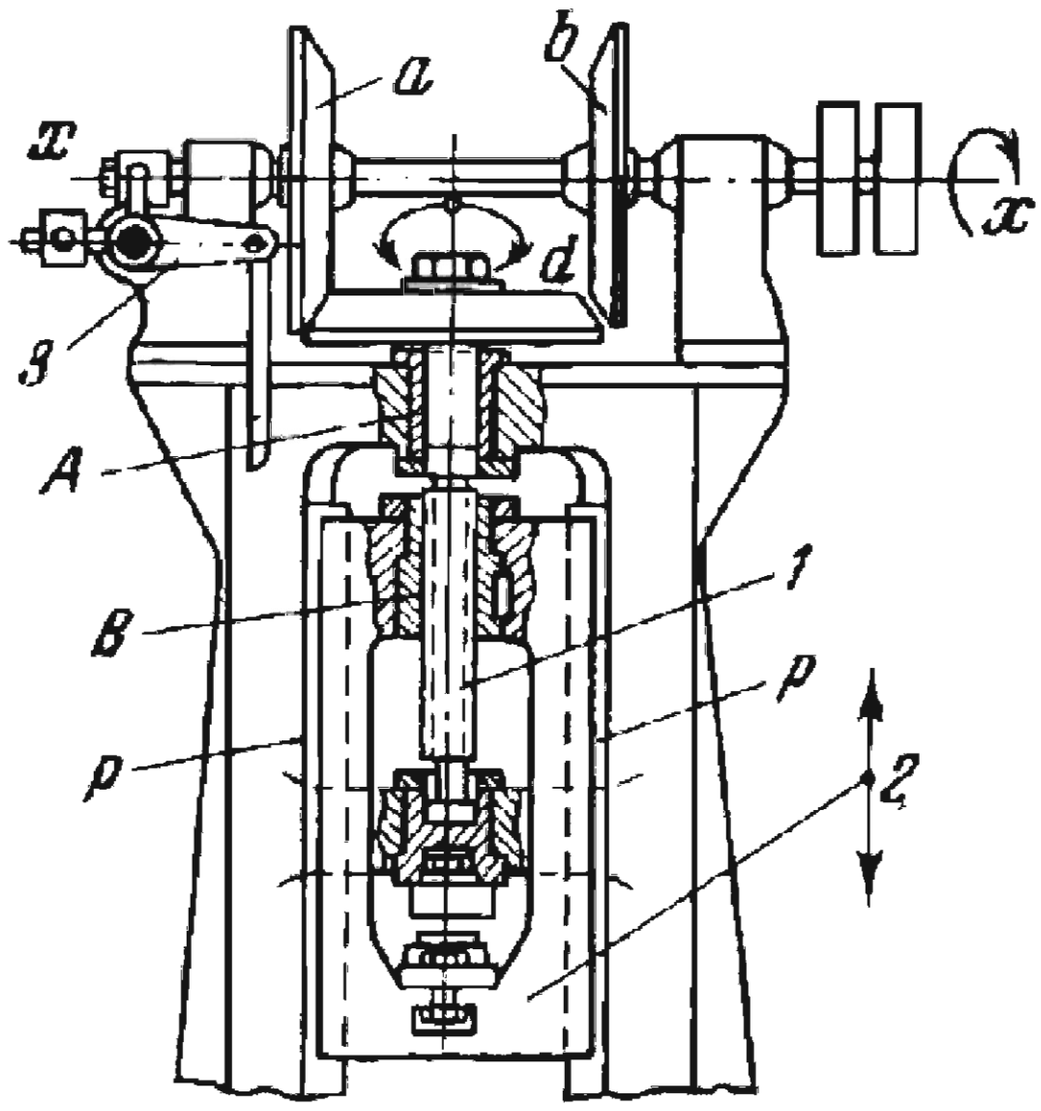
2241	SCREW-WEDGE TABLE FEED MECHANISM	LS SF



Link *1* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *3* which slides along fixed guide *p*. Link *3* has a bevelled surface which slides along corresponding bevelled surface *d* on table *2*. Table *2* slides vertically along axis *y-y* in suitable guides. When link *1* is rotated, table *2* is traversed vertically along axis *y-y*. Table travel is limited by pin *a* and flat *b* on a table guide.

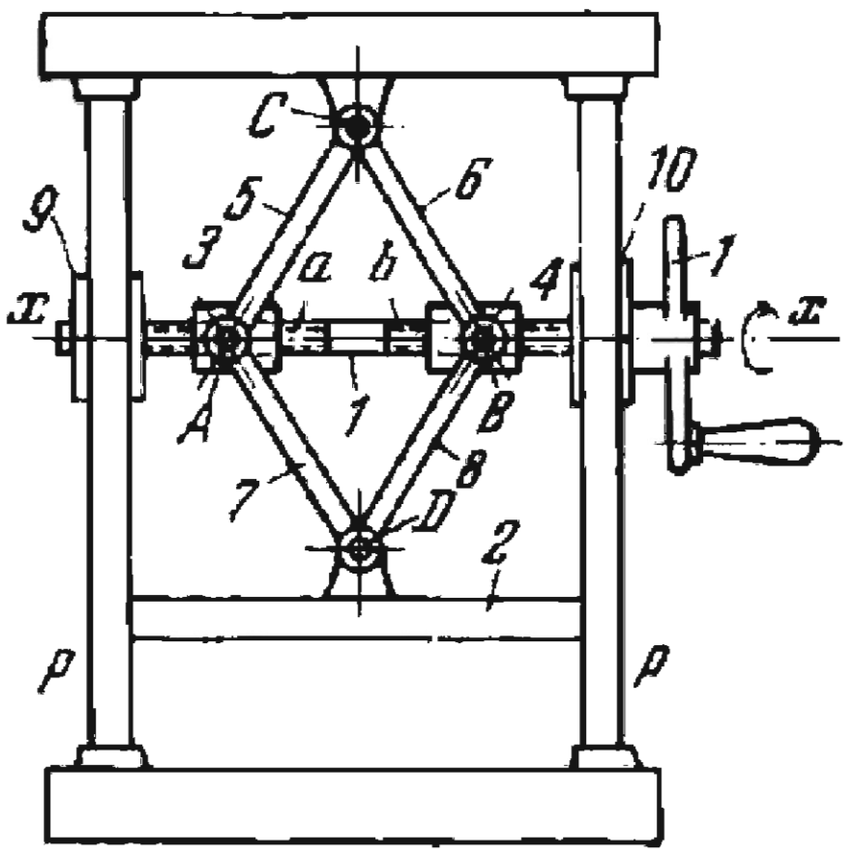
6. HAMMER, PRESS AND DIE MECHANISMS (2242, 2243 and 2244)

2242	FRICTION SCREW PRESS DRIVE MECHANISM	LS HP



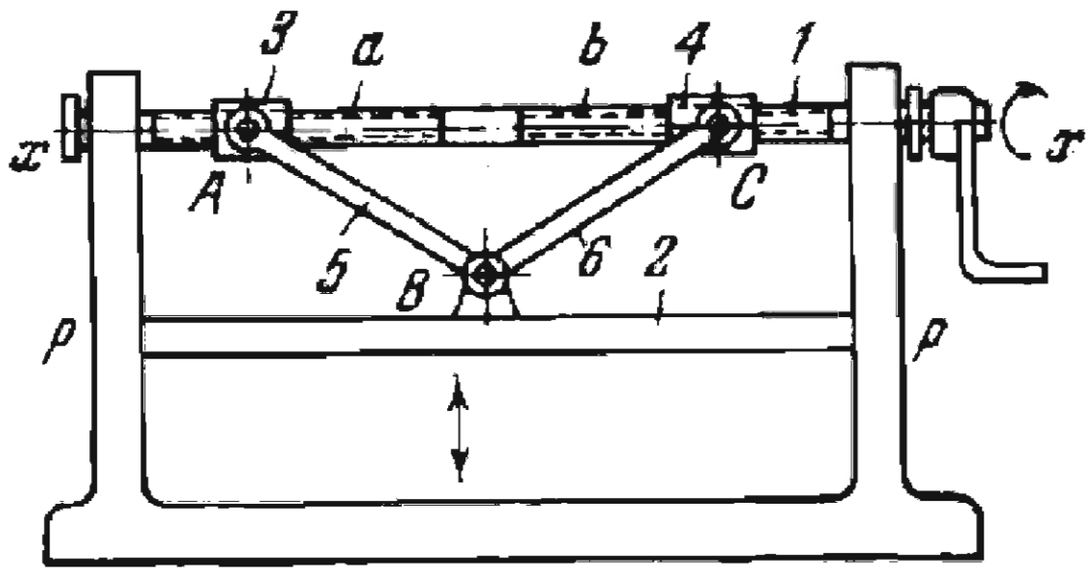
Link *1*, the press screw, is connected by turning pair *A* to the fixed link (press frame) and by screw pair *B* to press ram *2* which slides in fixed guides *p-p*. Link *1* has tapered friction wheel *d*. By means of a mechanism (not shown) link *3* alternately engages tapered friction wheels *a* and *b*, rotating about axis *x-x*, with wheel *d*. Thus link *1* is rotated first in one direction and then in the other. The alternating rotation of screw *1* is converted into reciprocation of ram *2*.

2243	LEVER-SCREW PRESS MECHANISM	LS HP



The lengths of the links comply with the condition: $\overline{AC} = \overline{CB} = \overline{BD} = \overline{DA}$. Link *1* rotates about axis *x-x* and is connected by screw pairs to links *3* and *4* which, in turn, are connected by turning pairs *A* and *B* to links *5*, *7*, *6* and *8*. The bearings of link *1* are mounted in slides *9* and *10* which move vertically along fixed guides *p-p*. Slide *2* moves along fixed guides *p-p* and is connected by turning pair *D* to links *7* and *8*. Links *5* and *6* turn about fixed axis *C*. Screw *1* has right- and left-hand threads, *a* and *b*, of equal pitch. When link *1* is rotated, link *2* slides along guides *p-p*.

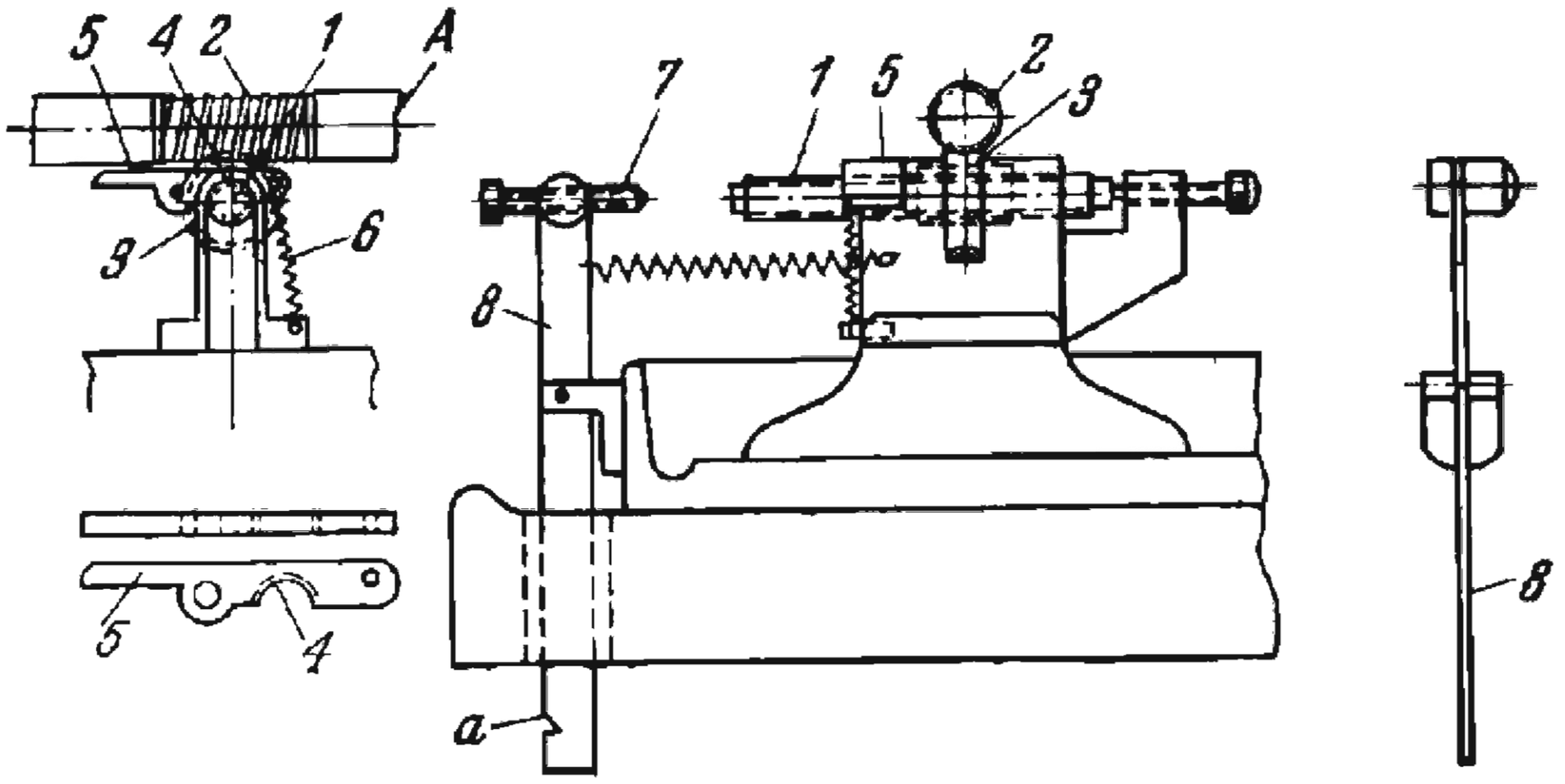
2244	LEVER-SCREW PRESS MECHANISM	LS HP



The lengths of the links comply with the condition: $\overline{AB} = \overline{BC}$. Link *1* rotates about fixed axis *x-x* and is connected by screw pairs to links *3* and *4* which, in turn, are connected by turning pairs *A* and *C* to links *5* and *6*. Slide *2* moves along fixed guides *p-p* and is connected by turning pair *B* to links *5* and *6*. Screw *1* has right- and left-hand threads, *a* and *b*, of equal pitch. When link *1* is rotated, link *2* slides along guides *p-p*.

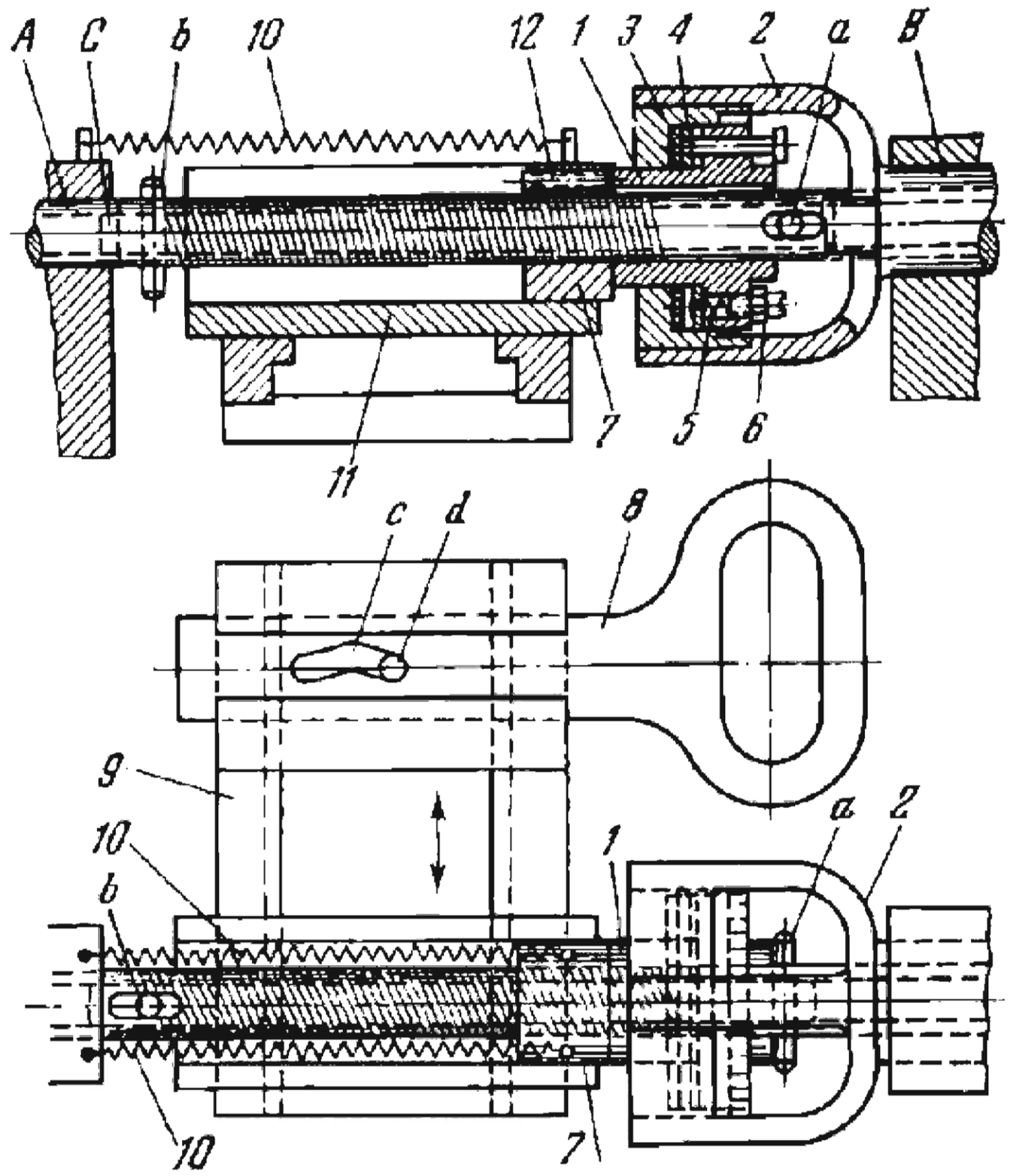
7. SWITCHING, ENGAGING AND DISENGAGING MECHANISMS (2245 and 2246)

2245	SCREW-TYPE DISENGAGING MECHANISM	LS SE



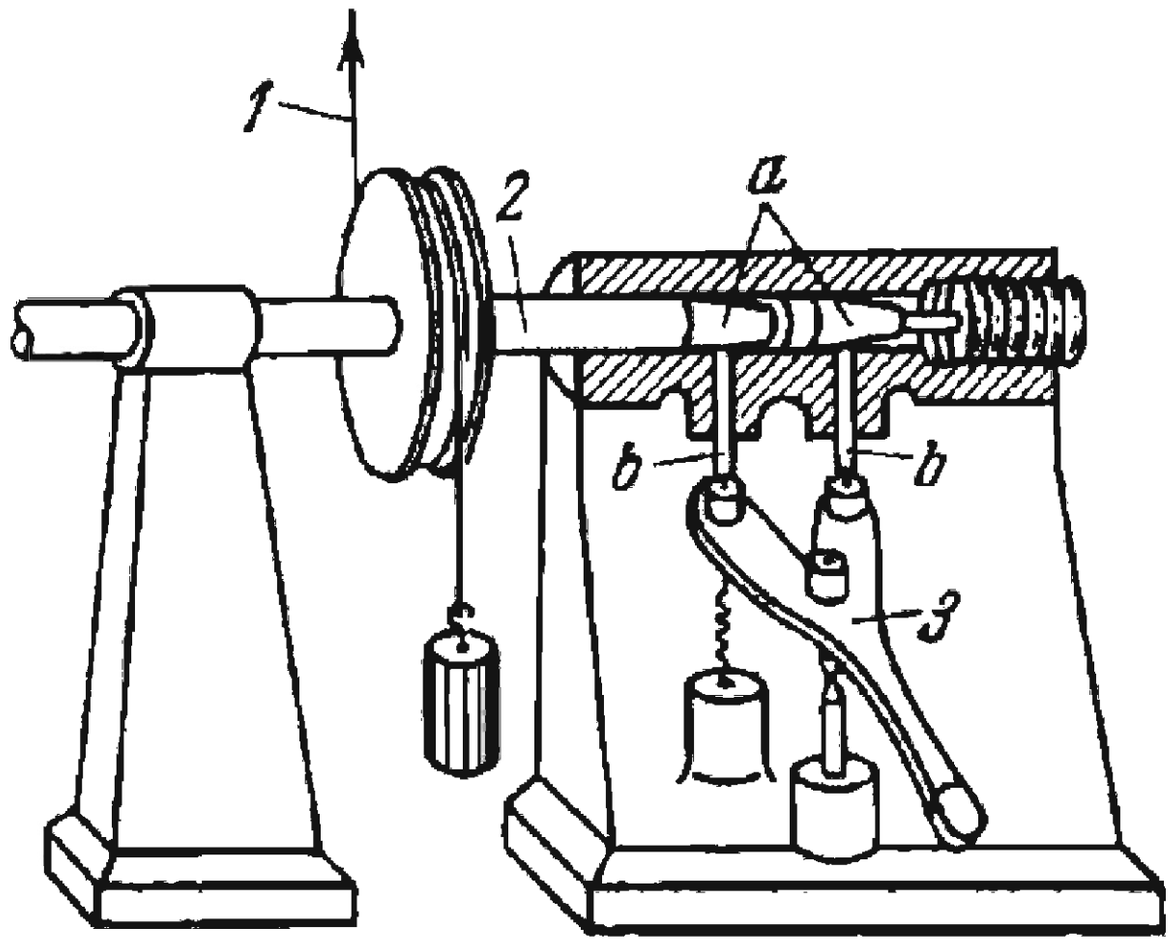
Screw *1* is driven by worm *2* and worm wheel *3* through a key which is held in worm wheel *3* and slides along a keyway cut along the length of screw *1*. Screw *1* fits the thread of half-nut *4* on lever *5*. Spring *6* holds the half-nut in contact with screw *1* which travels to the left when rotated. When screw *1* reaches setscrew *7* it pushes back lever *8* so that the stopping device of the machine (not shown) is disengaged from notch *a* and the machine stops. At this, shaft *A* ceases rotation. The time the machine operates before being disengaged is varied by adjusting setscrew *7*.

SCREW-TYPE DISENGAGING MECHANISM

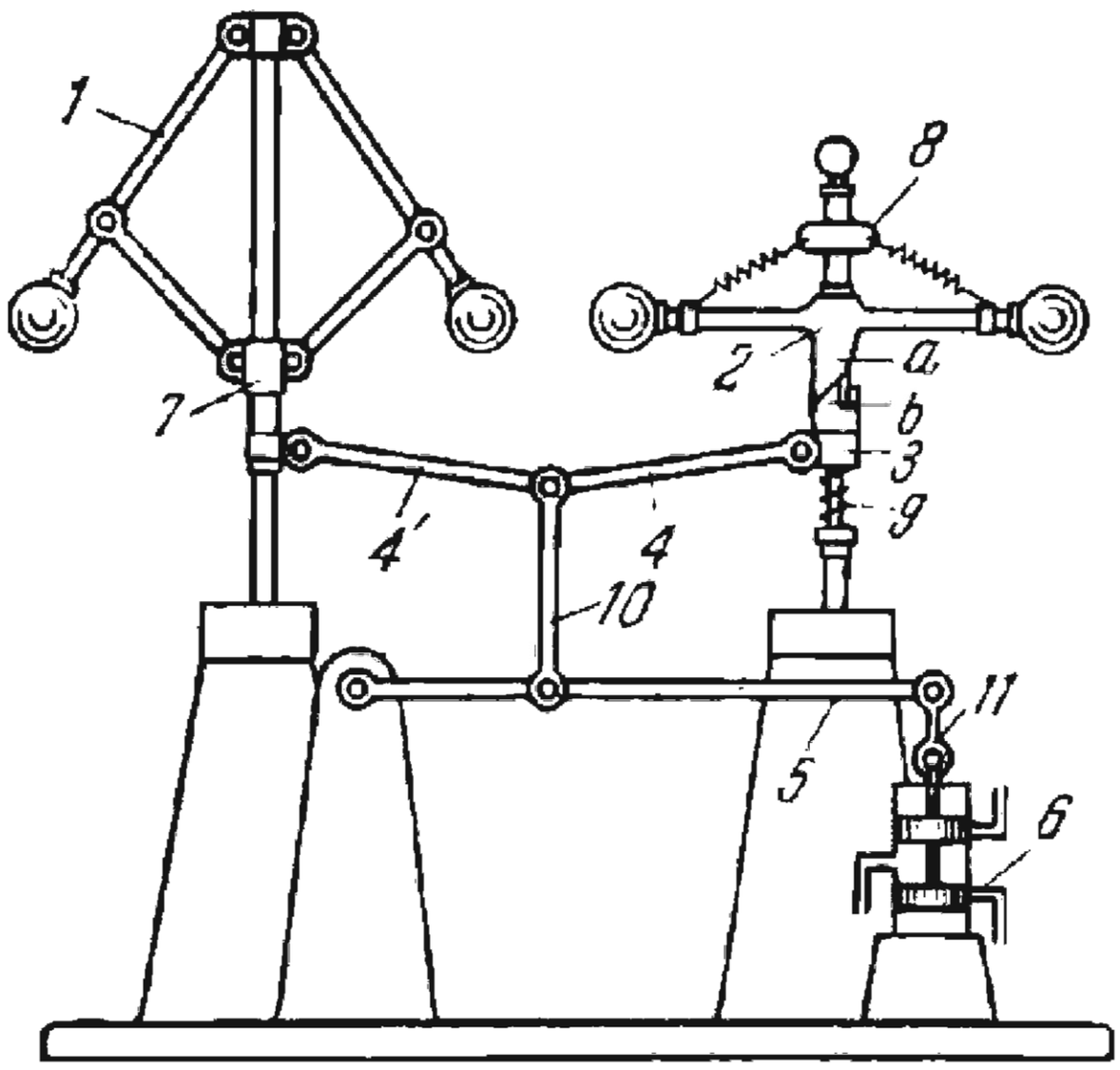


Driven shaft *A*, on which a screw thread has been cut, is rotated by toothed clutch member *1* which engages cross-shaped member *2*. Link *2* is rigidly connected to drive shaft *B*. By means of a friction clutch consisting of disks *3* and *4* and springs *5*, adjusted by screws *6*, teeth on clutch member *1* are brought into positive engagement with those on disk *3* so that member *1* rotates at the same speed as link *2* and drive shaft *B*. The friction and toothed clutches are held in the engaged position by pin *a* secured in rod *C* which slides within shaft *A*. Half-nut *7* bears against pin *b* of rod *C* when the half-nut is in its extreme left-hand position. The dimensions of screw *A* and half-nut are selected so that the half-nut can be engaged to or disengaged from screw *A* by horizontal motion of handle *8*. Cam slot *c* in handle *8* actuates pin *d* of slide *9*, moving the slide and half-nut *7* in the direction shown by the arrow. When half-nut *7* is engaged in its extreme left-hand position to screw *A*, it travels to the right to the position shown. Here it disengages clutch member *1* from cross-shaped member *2* so that shaft *A* stops after having turned a definite number of revolutions that depend on the length of the screw and its pitch. To engage shaft *A* again so that the machine, connected to shaft *A*, is started, half-nut *7* is disengaged by pulling handle *8*. At this half-nut *7* is shifted by springs *10* along guides *11* to the left where it strikes pin *b* so that pin *a* engages the friction and then toothed clutches. The exact number of revolutions of shaft *A* from the instant it starts to the instant it stops can be regulated by setscrew *12* in half-nut *7*. Its overhang determines the instant the toothed clutch is disengaged.

2247	LEVER-SCREW MECHANISM FOR DIRECT FEEDBACK IN FLEXIBLE-LINK GOVERNORS	LS G



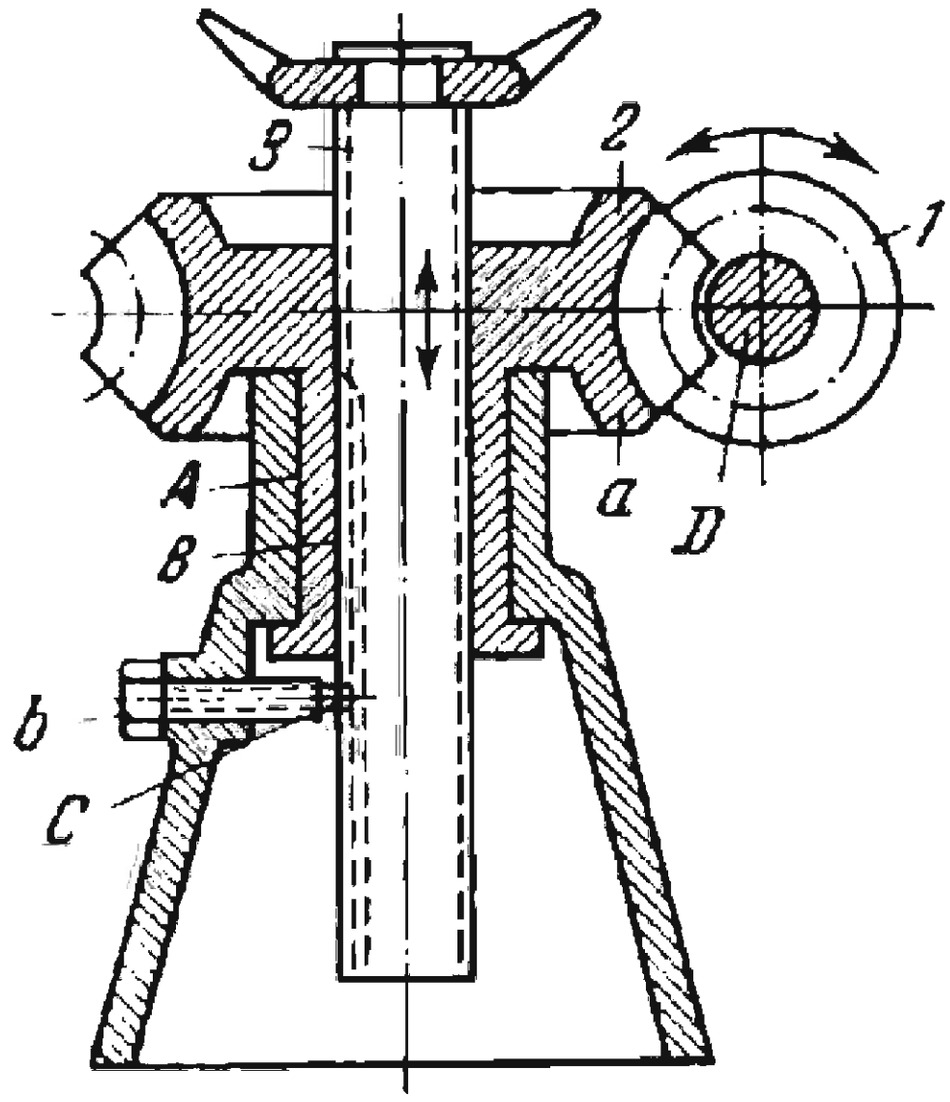
The displacement of the adjusting valve is transmitted by rope *1* to shaft *2* which has thread at its end. Axial displacement of shaft *2* is converted by its tapered journals *a* into displacement of pins *b*. Through lever *3* pins *b* actuate the shutter of the nozzle.



Centrifugal governor *1* reacts to changes in speed of the shaft being governed. Device *8*, consisting of two balls mounted on sleeve *2*, having helical cam surface *a*, reacts to changes in angular acceleration of the same shaft. Cam surface *a* contacts a corresponding projection *b* of sleeve *3* which is held against sleeve *2* by spring *9*. Sleeves *7* and *3* are connected by tie-rods *4'* and *4* of equal length. These tie-rods are connected by links *10*, *5* and *11* to valve *6*. The latter is connected to a servomotor (not shown) which regulates the speed of the shaft. When the speed of the shaft changes, the balls of the centrifugal governor are displaced, thereby displacing sleeve *7*. At the same time, sleeve *2*, due to the inertia of its balls, turns and helical cam surface *a* displaces sleeve *3* upward or downward, depending upon the sign of the angular acceleration.

9. MECHANISMS OF MATERIALS HANDLING EQUIPMENT (2249)

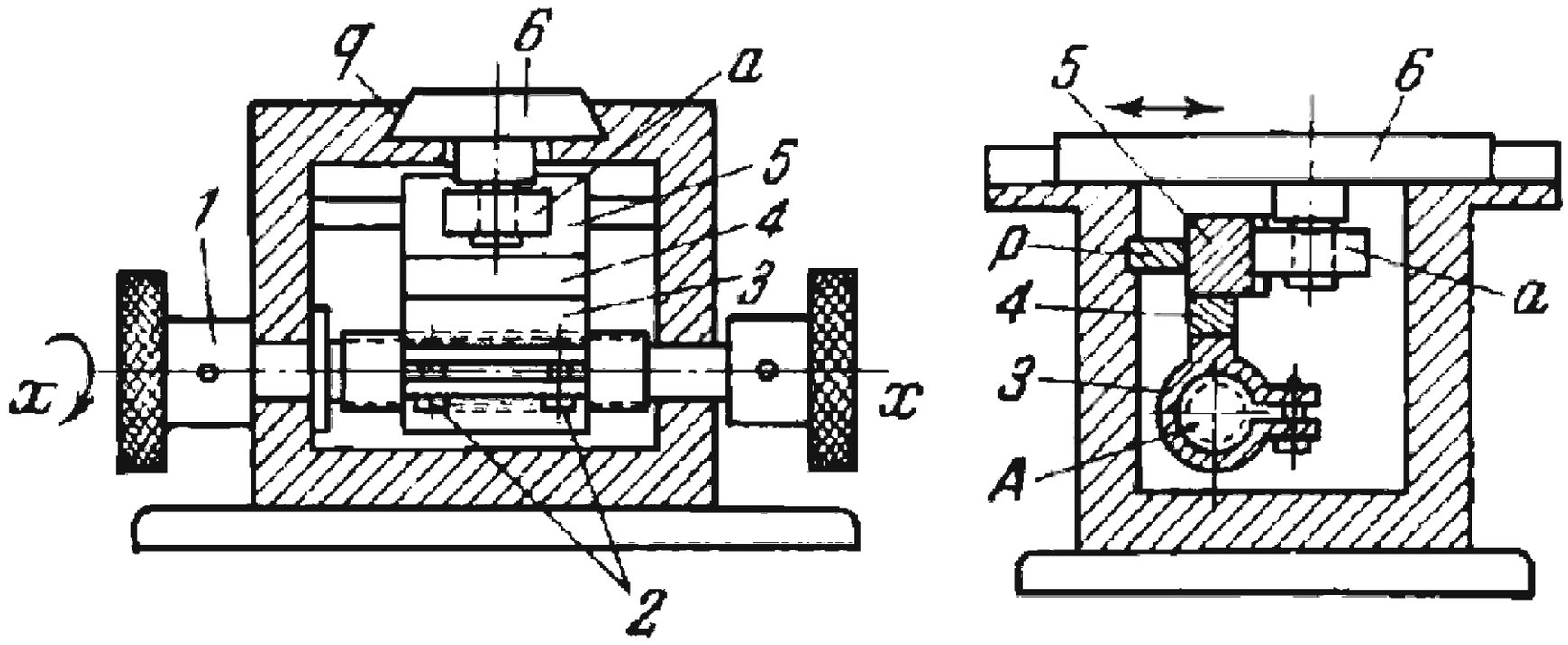
2249	WORM-DRIVEN SCREW JACK MECHANISM	LS MH



Worm *1* rotates about fixed axis *D* and meshes with worm wheel *a* of link *2*. Link *2* is connected by turning pair *A* to the fixed link and by screw pair *B* to link *3* which is connected, in turn, by sliding pair *C* to fixed bolt *b*. Rotation of worm *1* is converted into vertical sliding motion of link *3*.

10. PRECISE SETTING MECHANISMS (2250 through 2254)

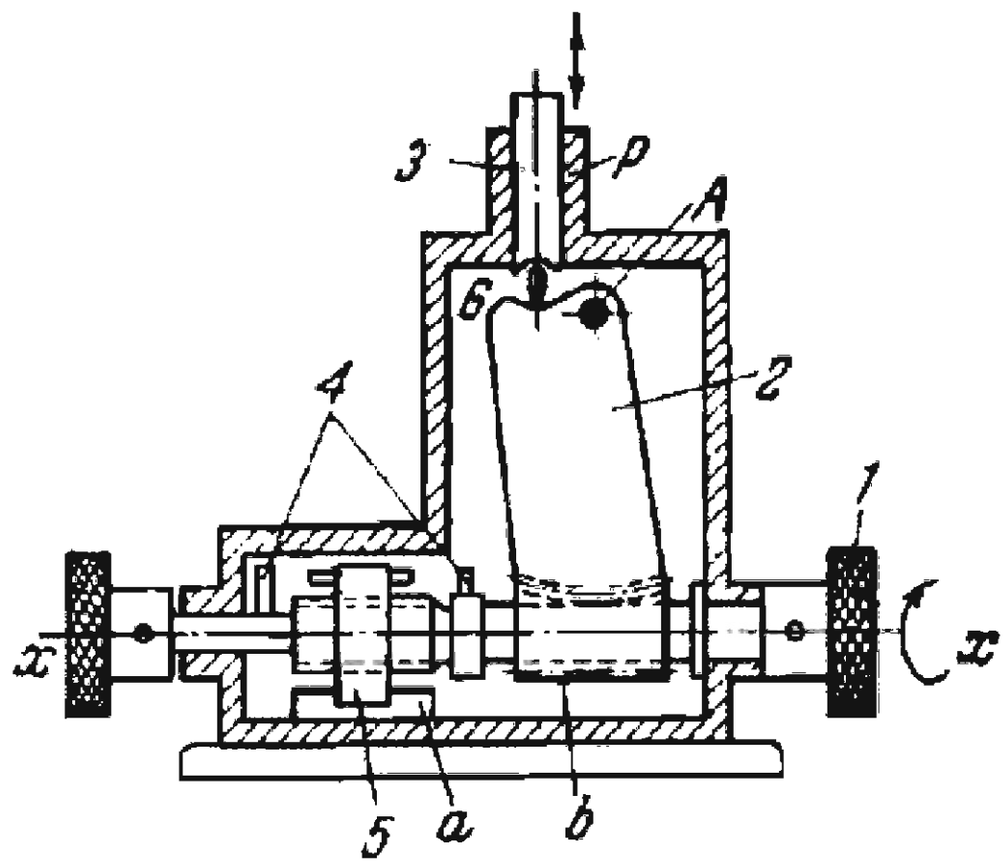
2250	SCREW-TYPE PRECISE SETTING MECHANISM	LS PS



Link *1* rotates about axis *x-x* and is connected by screw pair *A* **to link** *3*. Link *5* is of wedge shape and slides in fixed guide *p*. Through roller *a*, link *5* transmits motion to link *6* which slides in fixed guide *q*. Link *6* is set in the required position by turning adjusting link *1*. When link *1* is turned, link *3* is displaced and, through link *4*, actuates wedge *5*. This transmits sliding motion to link *6* through roller *a* mounted on link *6*. Clearance is eliminated in screw pair *A* by means of screws *2*. This reduces the backlash of the mechanism.

2251 SCREW-TYPE PRECISE SETTING MECHANISM

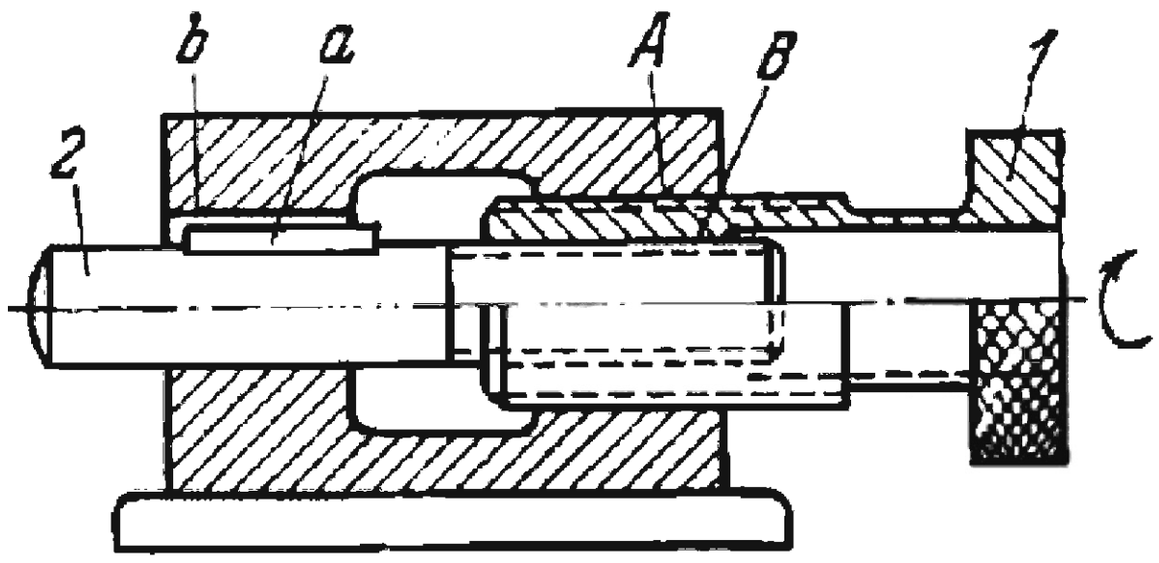
LS
PS



Link *1* rotates about fixed axis *x-x* and has worm *b* which meshes with worm-wheel segment *2*. Segment *2* rotates about fixed axis *A* and, through intermediate link *6*, transmits sliding motion to link *3* along fixed guide *p*. When adjusting link *1* is turned, worm-wheel segment *2* turns about axis *A* and sets driven link *3* in the required position. The amount that segment *2* can be turned is restricted by means of stops *4* and nut *5* which moves along guide *a* in the housing.

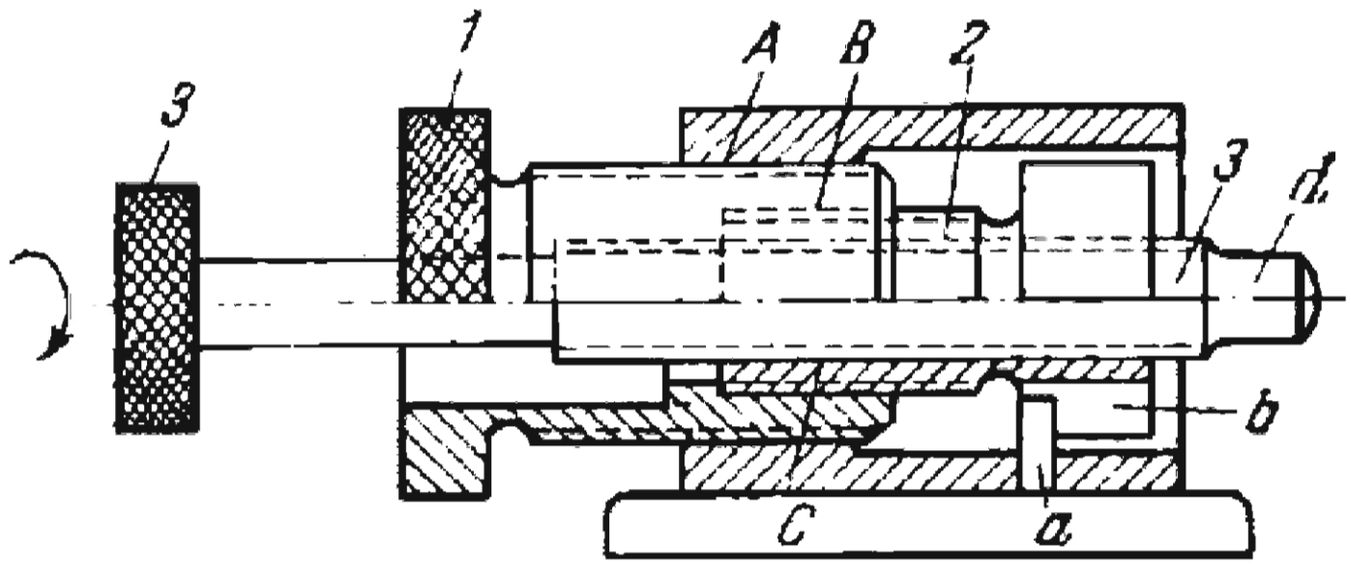
2252 DIFFERENTIAL-SCREW PRECISE SETTING MECHANISM

LS
PS



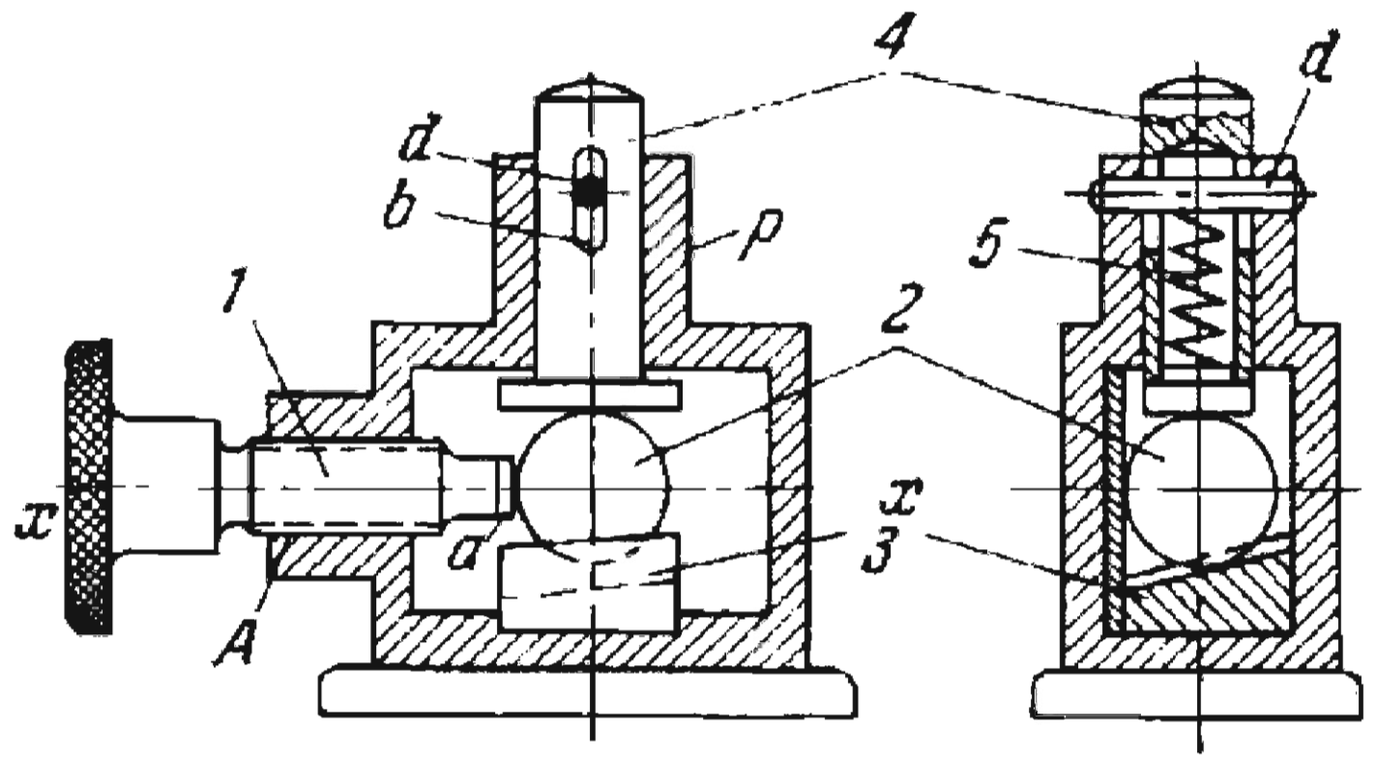
Link *1* is connected by screw pair *A* to the fixed link and by screw pair *B* to link *2*. Link *2* has key *a* which slides along keyway *b* of the fixed link. Adjusting link *1* has external and internal threads of the same hand and with a slight difference in pitch. When link *1* is turned one revolution, link *2*, prevented from turning by key *a*, is displaced a distance equal to the difference in the pitches of the external and internal threads.

2253	DIFFERENTIAL-SCREW PRECISE SETTING MECHANISM	LS PS



Link *1* is connected by screw pair *A* to the fixed link and by screw pair *B* to link *2* whose slot *b* slides along fixed pin *a*. Adjusting link *1* has external and internal threads of the same hand and with a slight difference in pitch. Link *3* is connected by screw pair *C* to link *2*. A rough setting of stop *d* is obtained by turning link *3*. Link *1* is turned for a precise setting.

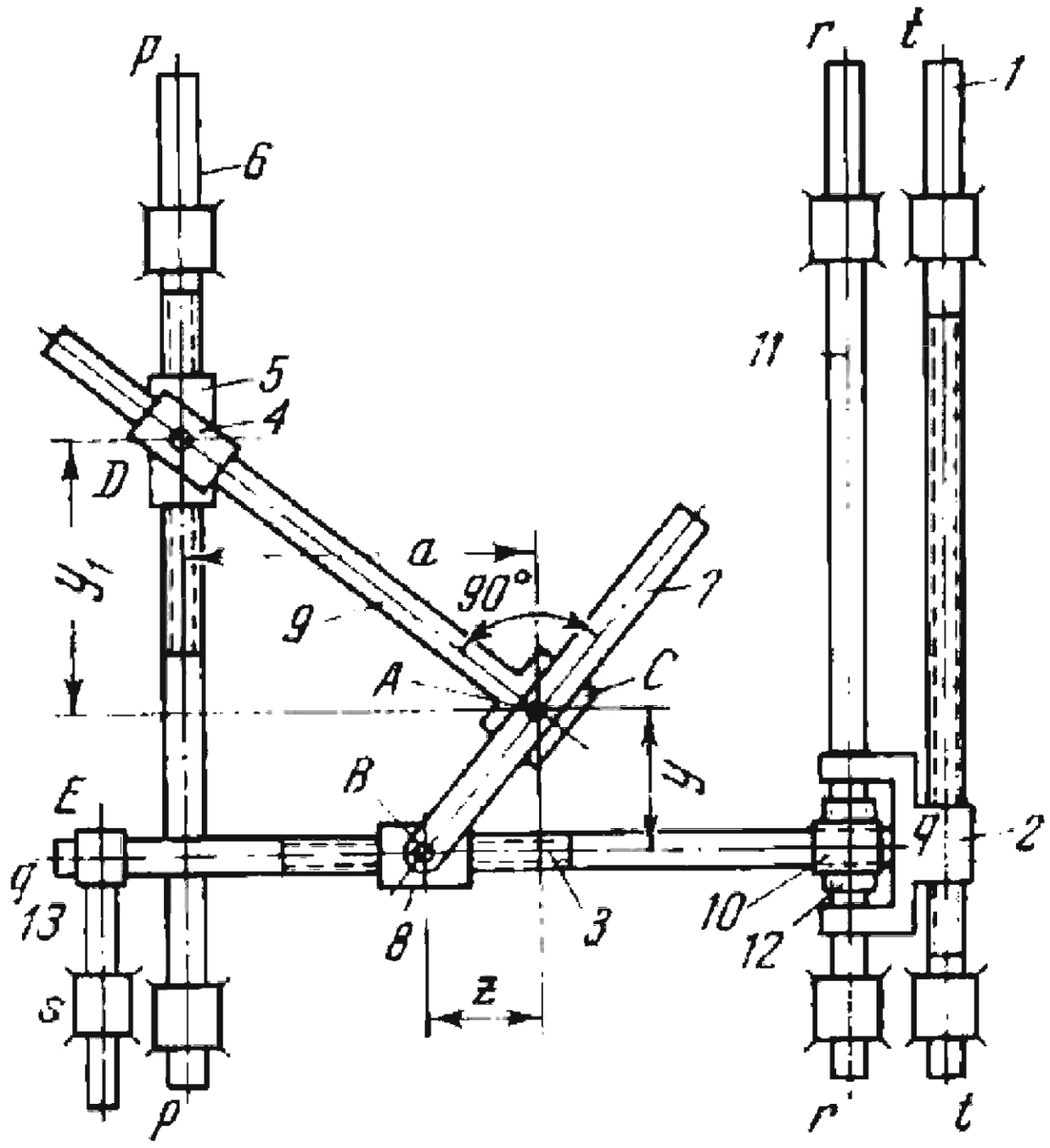
2254	SCREW-TYPE PRECISE SETTING MECHANISM	LS PS



Link *1* rotates about fixed axis *x-x* and is connected by screw pair *A* to the fixed link. Tip *a* of link *1* contacts ball *2* which rolls along inclined prismatic guide *3*. Link *4* slides in fixed guide *p* and has slot *b* sliding along fixed pin *d*. When adjusting link *1* is turned, ball *2* is displaced along guide *3* which is inclined in two directions. Ball *2* sets driven link *4* in the required position. Spring *5* holds the links of the mechanism in positive contact.

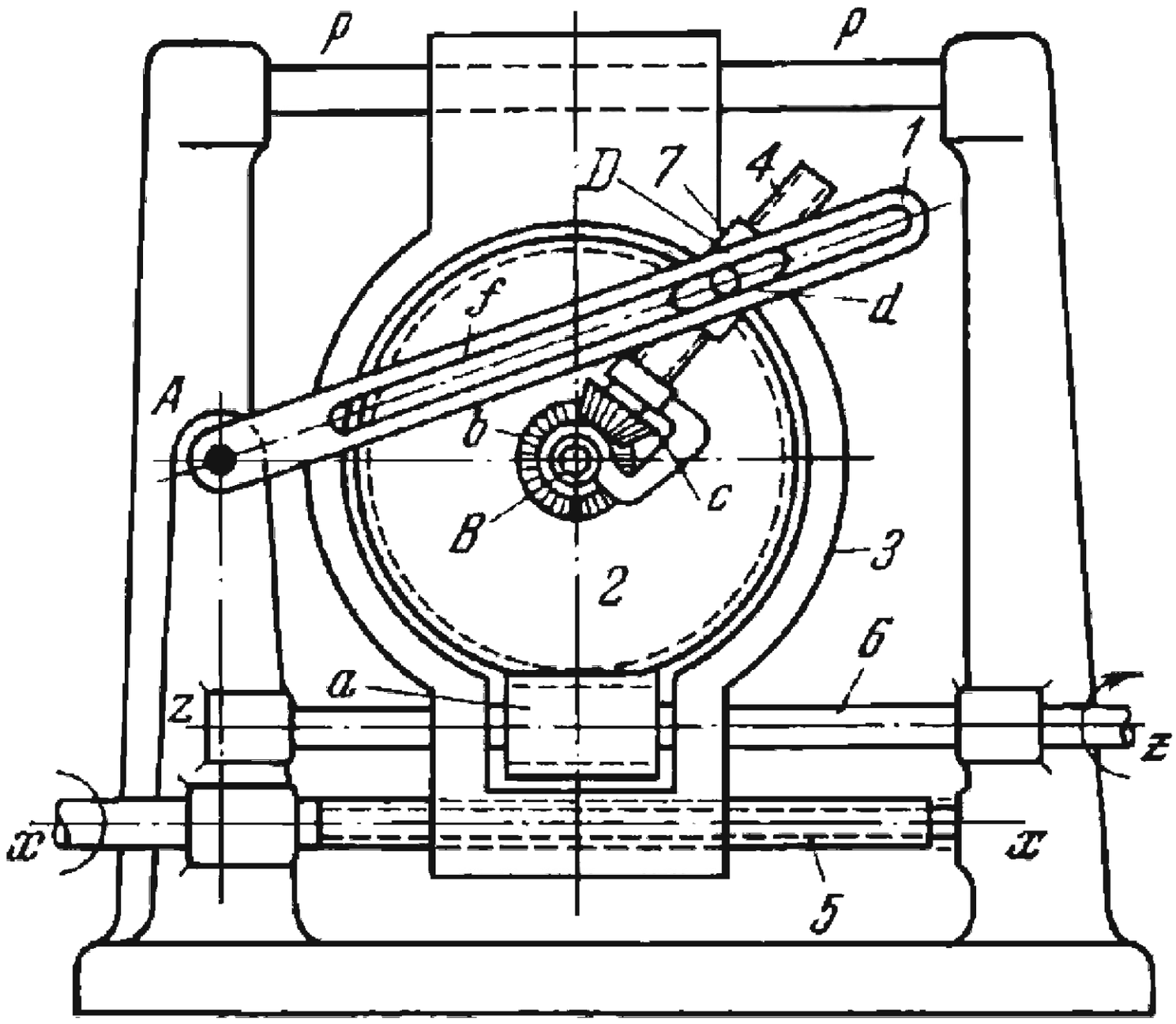
11. MECHANISMS FOR MATHEMATICAL OPERATIONS (2255 through 2266)

2255	LEVER-SCREW MULTIPLIER MECHANISM	LS MO



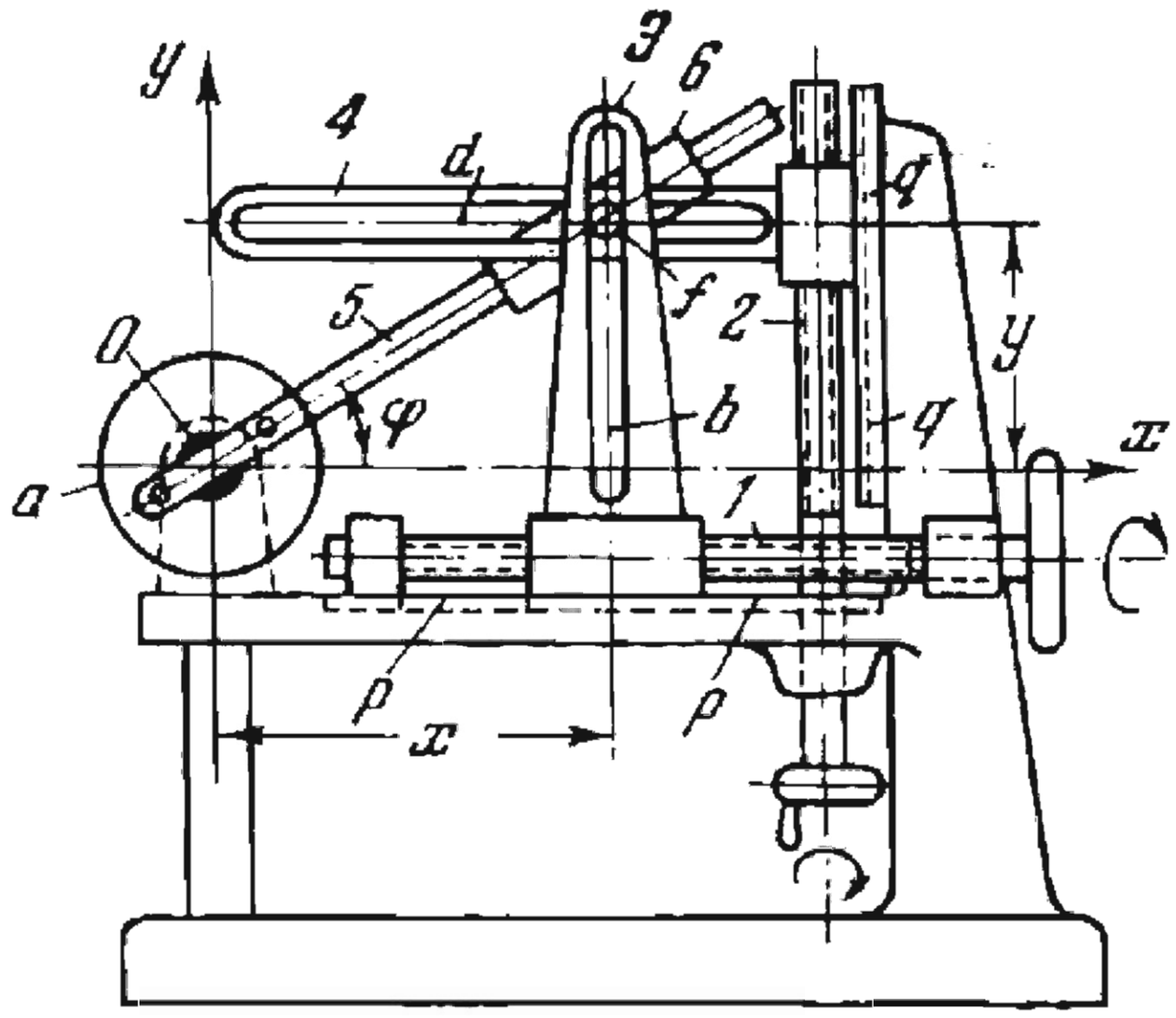
Link *1* rotates about fixed axis *t-t* and is connected by a screw pair to link *2* which slides along axis *r-r* of link *11*. Sliding along link *11* on a key is spiral gear *12* which meshes with spiral gear *10* (crossed helical gearing) of link *3*. Gear *12* fits between the prongs of link *2* which traverses it along link *11*. Link *3* is connected by a screw pair to slider *8* and rotates about axis *q-q* which is perpendicular to axes *t-t* and *r-r*. Link *3* is connected by turning pair *E* to link *13* which slides in fixed guide *s* in the direction parallel to axes *t-t* and *r-r*. Link *7* is connected by turning pair *B* to slider *8* and by sliding pair *C* to link *9* which turns about fixed axis *A*. Link *9* is connected by a sliding pair to slider *4* which, in turn, is connected by turning pair *D* to slider *5*. Slider *5* is connected by a screw pair to link *6* which rotates about fixed axis *p-p*. The screw threads on link *3* have a helix angle greater than the angle of friction. One factor is entered by rotating link *6* to displace slider *5* vertically by the distance y_1. The second factor is next entered by rotating link *1* to displace link *3* vertically by the distance y. This moves point *B* along the axis of link *3* by a distance equal to $z = \frac{1}{a} y y_1$, where a is a constant dimension of the mechanism. As slider *8* moves along link *3* it rotates the link. This is transmitted through crossed helical gears *10* and *12* to link *11* whose rotation is proportional to displacement *z*.

2256	SCREW-GEAR DIFFERENTIAL MECHANISM FOR ADDING VECTORS	LS MO

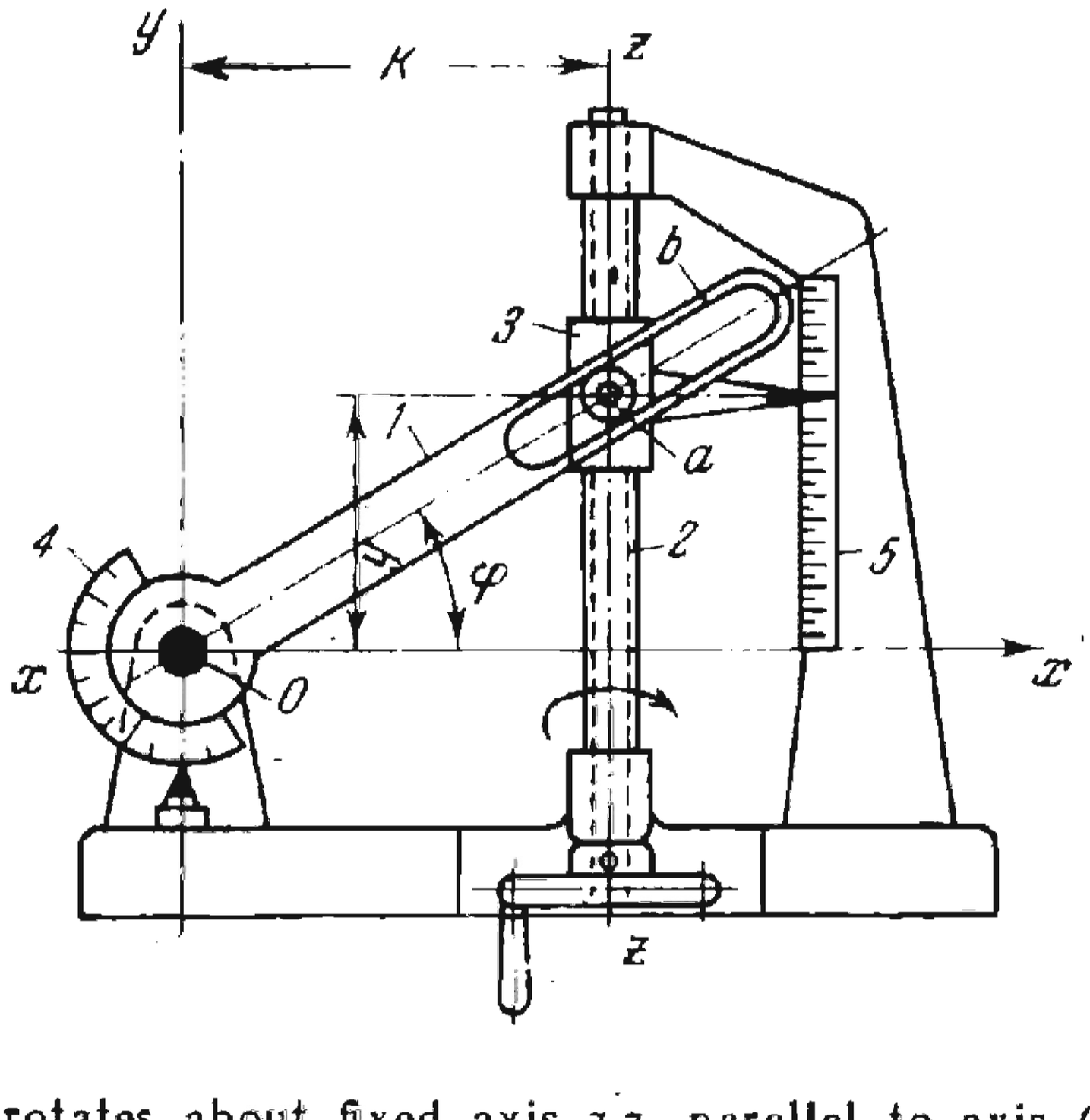


Link *5* rotates about fixed axis *x-x* and is connected by a screw pair to link *3* which slides along fixed guides *p-p*. Link *6* rotates about fixed axis *z-z* and has worm *a* which meshes with worm wheel *2*. Worm wheel *2* rotates about axis *B* of link *3*. Rigidly attached to worm wheel *2* is bevel gear *b* which meshes with gear *c* of link *4*. Link *4* is connected by screw pair *D* to slider *7* which has pin *d* sliding along slot *f* of link *1*. Link *1* turns about fixed axis *A*. The mechanism adds two vectors, $\overline{AB}$ and $\overline{BD}$. Vector $\overline{AB}$ is entered by displacing link *3* by means of screw *5*, and vector $\overline{BD}$ by displacing slider *7* by means of worm gearing between links *6* and *2* and a screw drive between links *4* and *7*. The resultant vector is $\overline{AD} = \overline{AB} + \overline{BD}$.

2257	SCREW-TYPE SLOTTED-LINK TANGENT GENERATOR	LS MO



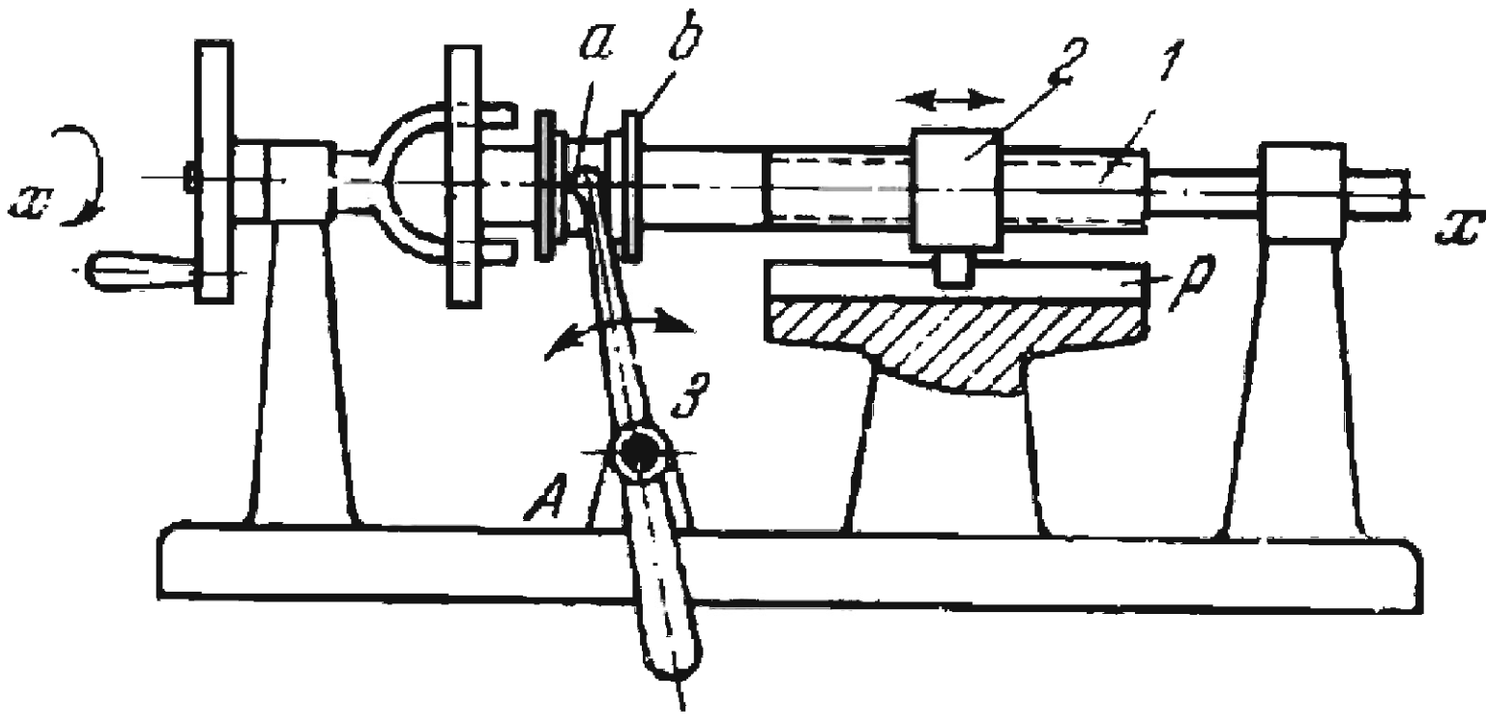
Link *5* with graduated dial *a* turns about fixed axis *O*. Link *3* with slot *b* is traversed by screw *1* which rotates about a fixed axis, parallel to axis *Ox*. Link *3* slides along fixed guides *p-p*. Link *4* with slot *d* is traversed by screw *2* which rotates about a fixed axis, parallel to axis *Oy*. Link *4* slides along fixed guides *q-q*. Link *5* is connected by a sliding pair to slider *6* which has pin *f* that slides simultaneously in slots *b* and *d* of links *3* and *4*. The tangent of the angular displacement of link *5* is proportional to the ratio of the linear displacements *x* and *y* of links *3* and *4*, traversed by screws *1* and *2*, and is determined by the equation $\tan\varphi = \frac{y}{x}$.



Link *2* rotates about fixed axis *z-z*, parallel to axis *Oy*, and is connected by a screw pair to link *3* which has pin *a* sliding along slot *b* of link *1*. Link *1* turns about fixed axis *O*. Displacement *y* of nut *3* is proportional to the tangent of angle φ, i.e. $y = k \tan \varphi$, where *k* is a constant dimension of the mechanism.

2259 LEVER-SCREW ADDING MECHANISM

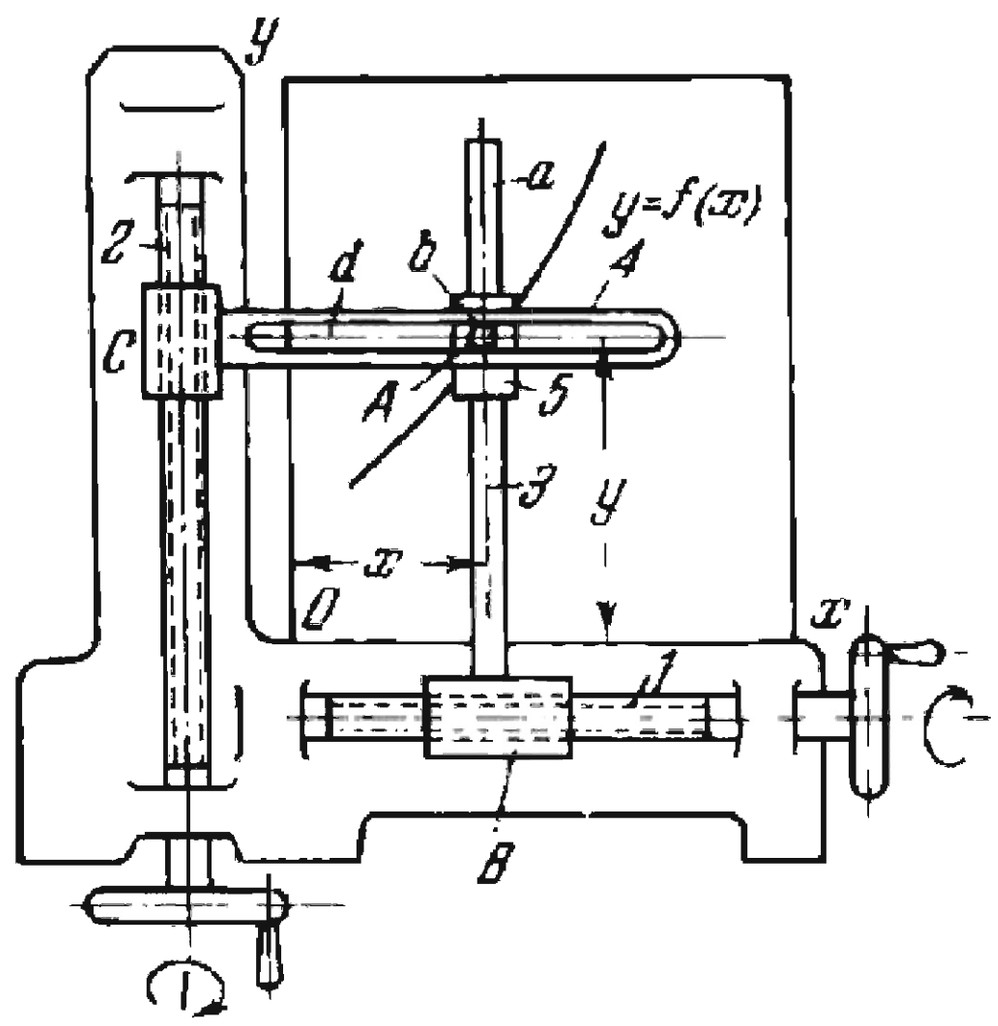
LS MO



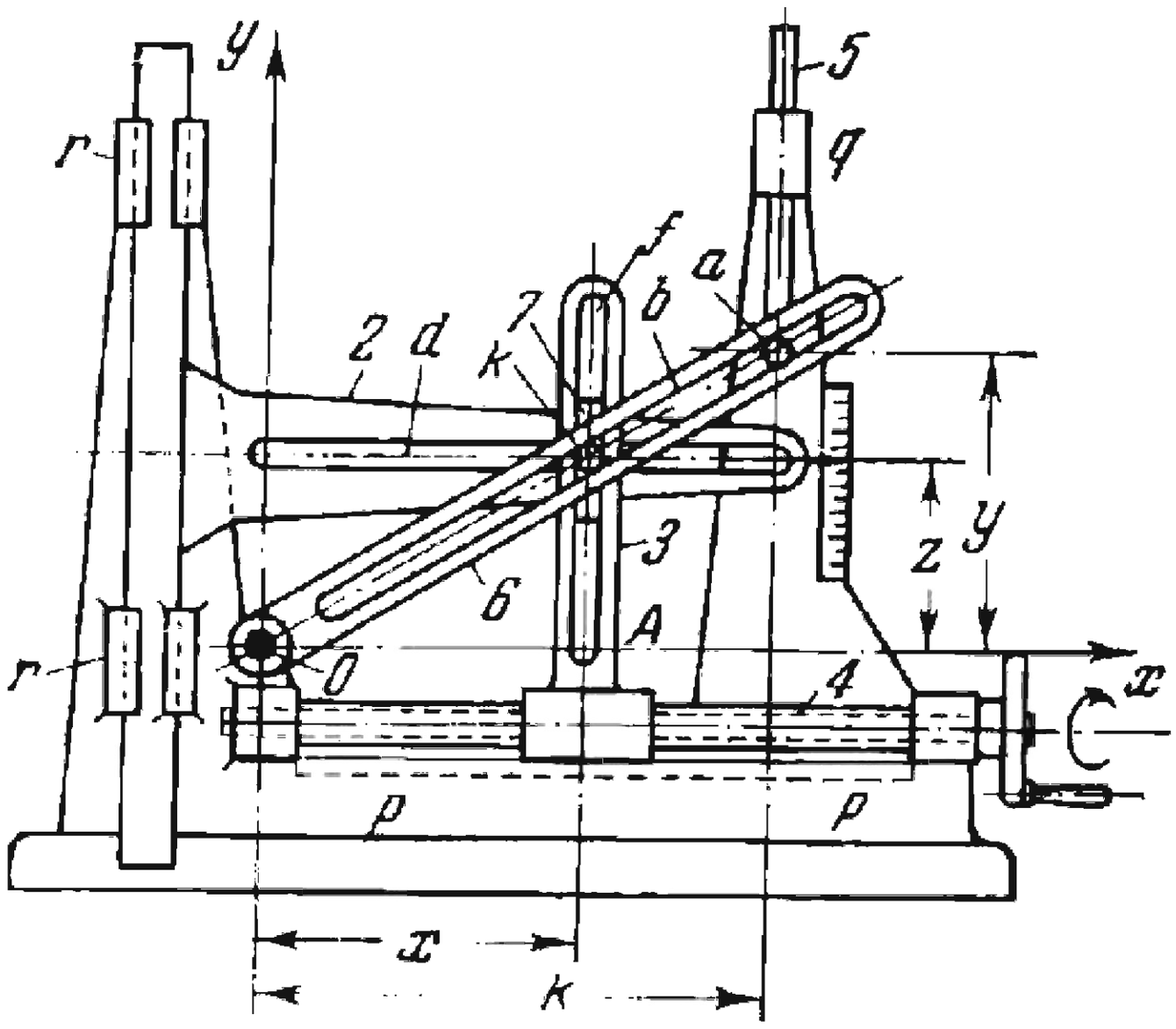
Link *1* rotates about fixed axis *x-x* and is connected by a screw pair to link *2* which slides along fixed guide *p*. Lever *3* turns about fixed axis *A* and has pin *a* which enters groove *b* of link *1*. The displacement of link *2* is the sum of its displacement due to the rotation of screw *1* about axis *x-x* and its displacement due to the axial traverse of link *1* along the same axis when lever *3* is turned.

2260 SCREW-TYPE SLOTTED-LINK MECHANISM FOR DETERMINING COORDINATES OF A CURVE

LS MO



Link *1* rotates about a fixed axis, parallel to axis *Ox*, and is connected by screw pair *B* to link *3*. Link *2* rotates about a fixed axis, parallel to axis *Oy*, and is connected by screw pair *C* to link *4*. Slider *5* moves along cross-piece *a* of link *3*, parallel to axis *Oy*, and has pin *b* which slides along slot *d* of link *4*. Slot *d* is parallel to axis *Ox*. Turning screws *1* and *2* so that point *A*, the intersection of the axes of pin *b* and slot *d* of links *5* and *4*, lies on the given curve $y = f(x)$, the coordinates *x* and *y* of this curve can be measured.

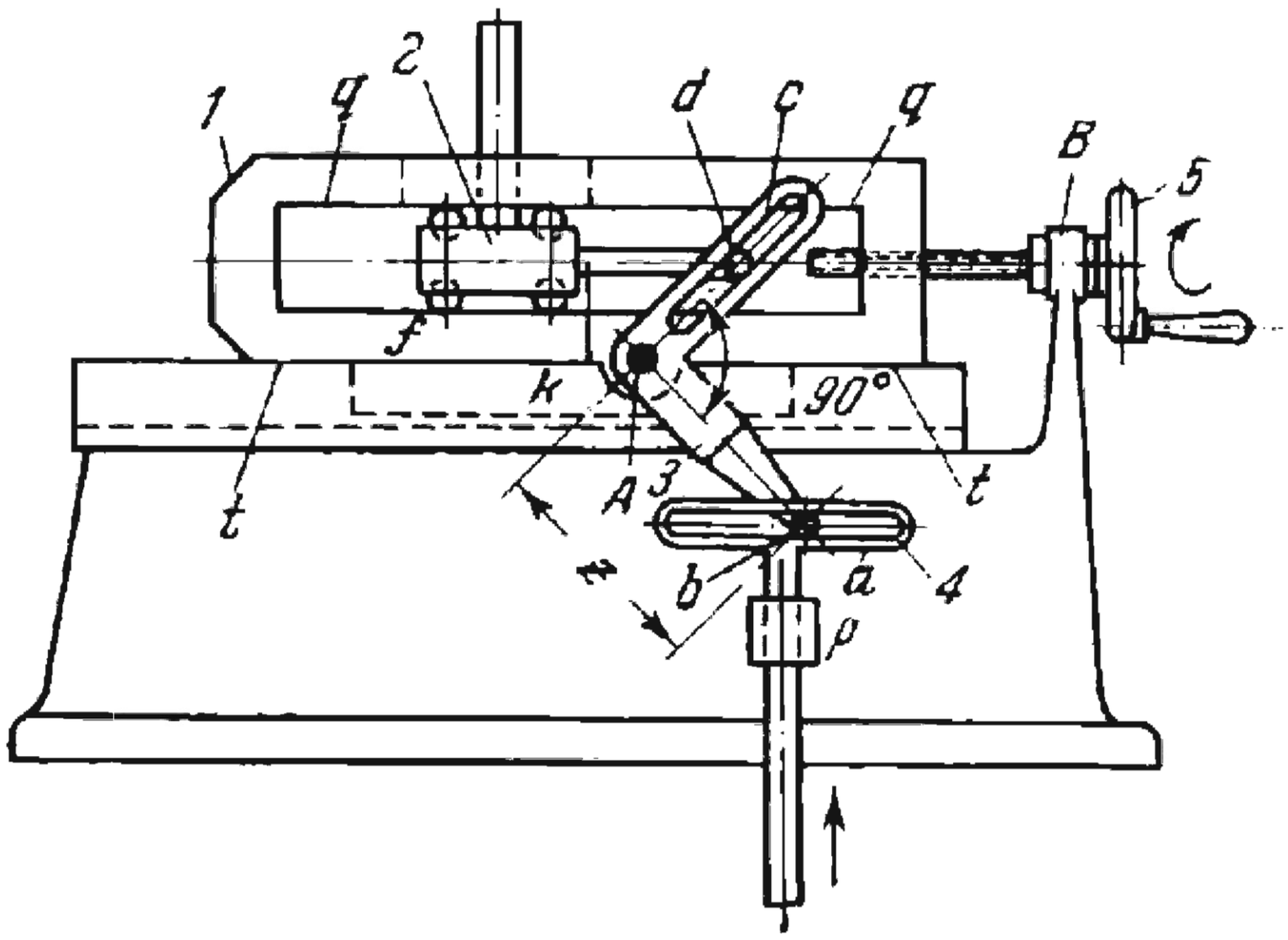


Link *4* rotates about a fixed axis parallel to axis *Ox* and is connected by screw pair *A* to link *3* which slides along fixed guides *p-p*. Link *5* slides in fixed guide *q*, whose axis is parallel to axis *Oy*, and has pin *a* which slides along slot *b* of link *6*. Link *6* turns about fixed axis *O*. Slider *2* moves in fixed guides *r-r*, whose axis is parallel to axis *Oy*, and has slot *d* whose axis is parallel to axis *Ox*. Slider *7* moves along slot *f* of link *3*, whose axis is parallel to axis *Oy*, and has pin *k* which slides simultaneously along slots *b*, *d* and *f*. Displacing link *3* by the distance *x* and link *5* by the distance *y* we obtain the displacement of link *2*:

$$z = \frac{1}{k} xy$$

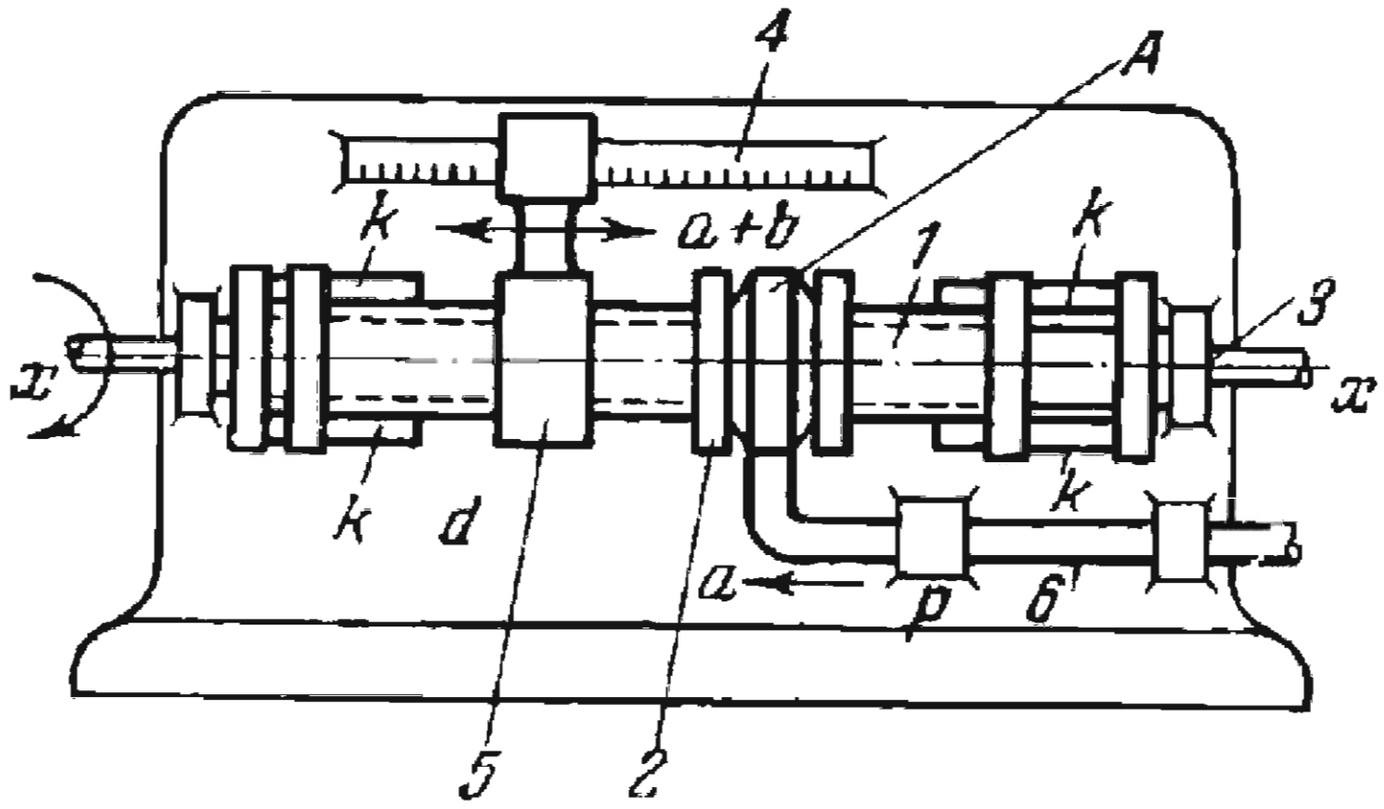
where *k* is a constant dimension of the mechanism.

2262	SCREW-TYPE SLOTTED-LINK ADDING MECHANISM	LS MO

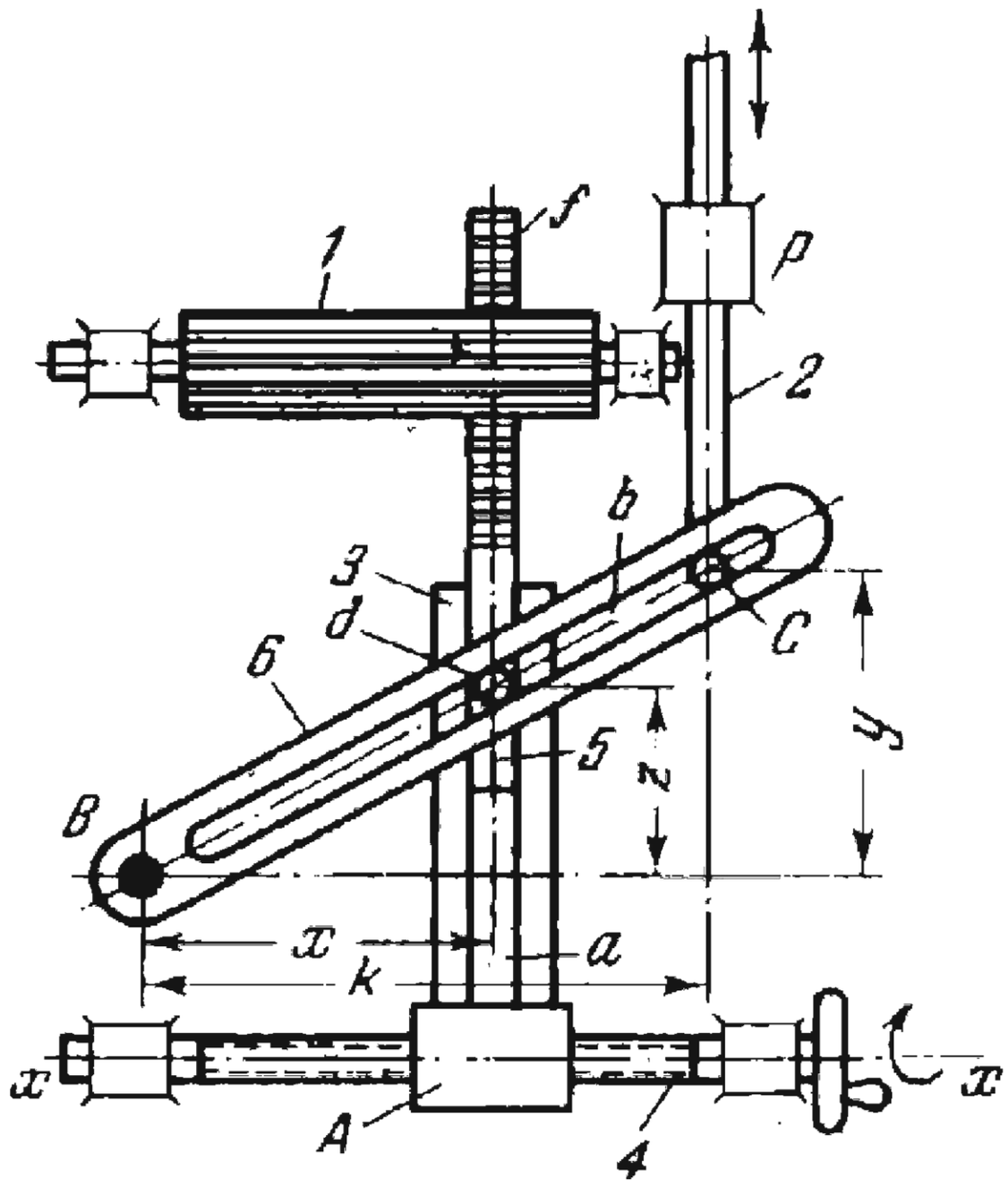


Link *4* with slot *a* slides in fixed guide *p*. Sliding along slot *a* is pin *b* of link *3* which turns about fixed axis *A*. Link *3* has slot *c* along which pin *d* of carriage *2* slides. Carriage *2* has rollers *f* which roll along guides *q-q*. Link *1* slides along fixed guides *t-t* and is traversed by link *5* which is connected by a screw pair to link *1* and by turning pair *B* to the fixed link. The displacement s_2 of carriage *2* is equal to the sum of the displacement s_1 of carriage *2* together with link *1*, obtained by rotating screw *5*, and displacement s_4 of carriage *2* due to the sliding motion of link *4* in guide *p*.

2263	SCREW-TYPE ADDING MECHANISM	LS MO



Link *1* is a hollow shaft on which a screw thread of large pitch has been cut. Link *1* rotates about fixed axis *x-x*. Shaft *3* rotates about axis *x-x* and passes through link *1*. Link *6* slides in fixed guide *p* and is connected by turning pair *A* to link *2* which, in turn, is connected by a screw pair to link *1*. One of the addends *a* is entered by the sliding motion of link *2*. The magnitude of this addend is indicated on scale *4* by means of link *5*. The second addend *b* is entered by turning shaft *3* which is connected to hollow shaft *1* by means of pins *k* which enter holes in the flanges of shaft *1*. The magnitude of the second addend is also indicated on scale *4* by subsequent displacement of link *5*. The sum $c = a + b$ is obtained as the result of the two displacements.



Link *4* rotates about fixed axis *x-x* and is connected by screw pair *A* to link *3* which has slot *a* perpendicular to axis *x-x*. Slider *5* moves along slot *a* of link *3*. Link *6* turns about fixed axis *B* and has slot *b* along which pin *d* of slider *5* and pin *C* of link *2* slide. Link *2* slides in fixed guide *p* whose axis is perpendicular to axis *x-x*. Slider *5* has gear rack *f* which meshes with gear *1*. Gear *1* rotates about a fixed axis parallel to axis *x-x*. When link *2* is displaced the distance *y* and link *3* the distance *x*, the displacement *z* of rack *f* of slider *5* is

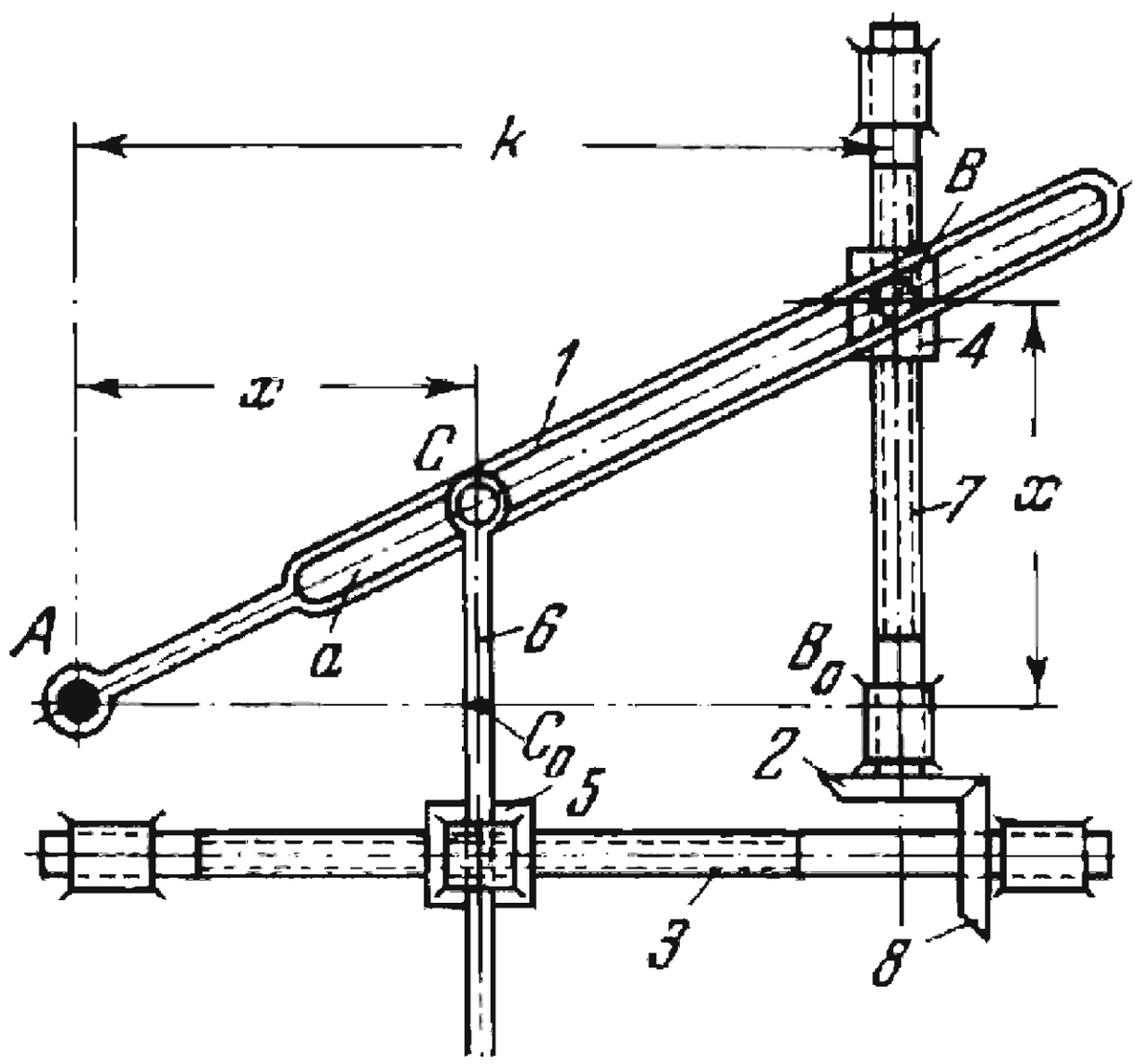
$$z = \frac{1}{k} xy$$

where *k* is a constant dimension of the mechanism. The magnitude of *z* is proportional to the angle φ of rotation of gear *1*. We have

$$\varphi = \frac{1}{rk} xy$$

where *r* is the pitch radius of gear *1*.

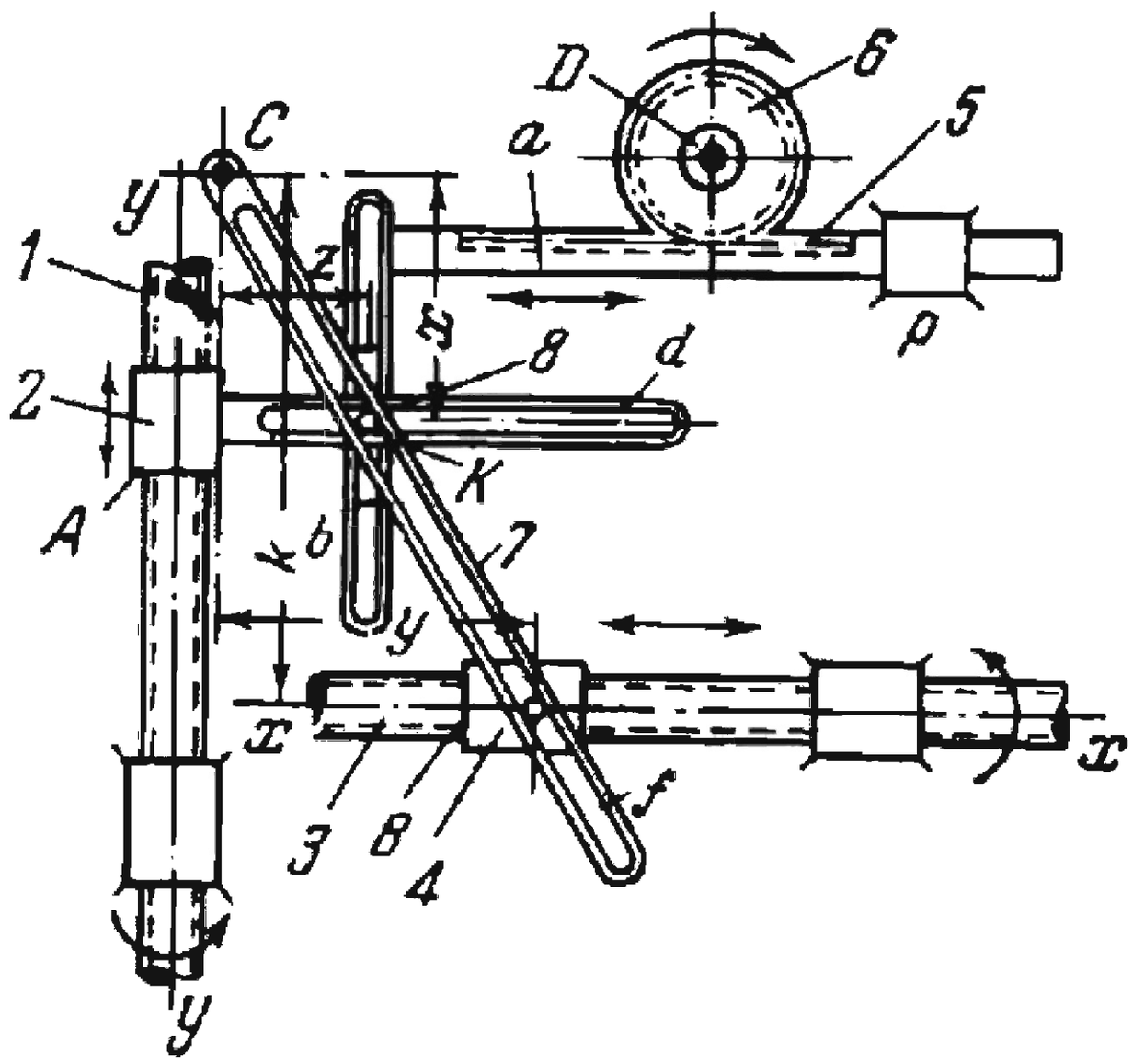
2265	SCREW-TYPE SLOTTED-LINK FOR RAISING TO A POWER	LS MO



Pins C and B of links *6* and *4* slide along slot a of slotted link *1* which turns about fixed axis A. Nuts *4* and *5* are connected by screw pairs to links *7* and *3* whose axes are perpendicular to each other. Nuts *4* and *5* are traversed by the rotation of meshing bevel gears *2* and *8*. The transmission ratio of gears *2* and *8*, and the pitches of screws *3* and *7* are selected so that nuts *4* and *5* travel at the same speed. The nuts are set to comply with the condition: $\overline{AC_0} = \overline{BB_0} = x$. Then displacement $s_6 = \overline{CC_0}$ of link *6* along the axis of this link is

$$s_6 = \frac{1}{k} x^2$$

where k is a constant dimension of the mechanism.



Link *1* rotates about fixed axis *y-y* and is connected by screw pair *A* to link *2*. Link *3* rotates about fixed axis *x-x*, perpendicular to axis *y-y*, and is connected by screw pair *B* to link *4*. Link *7* turns about fixed axis *C*. Link *5* slides in fixed guide *p* whose axis is parallel to axis *x-x*. Gear rack *a* of link *5* meshes with gear *6* which rotates about fixed axis *D*. Link *5* has slot *b* whose axis is parallel to axis *y-y*. Slider *8* moves along slot *b* and has pin *K* which slides simultaneously along slot *f* of link *7* and slot *d* of link *2*. The axis of slot *d* is parallel to axis *x-x*. When link *2* is displaced a distance *x* and link *4* a distance *y*, the displacement of rack *a* of link *5* is

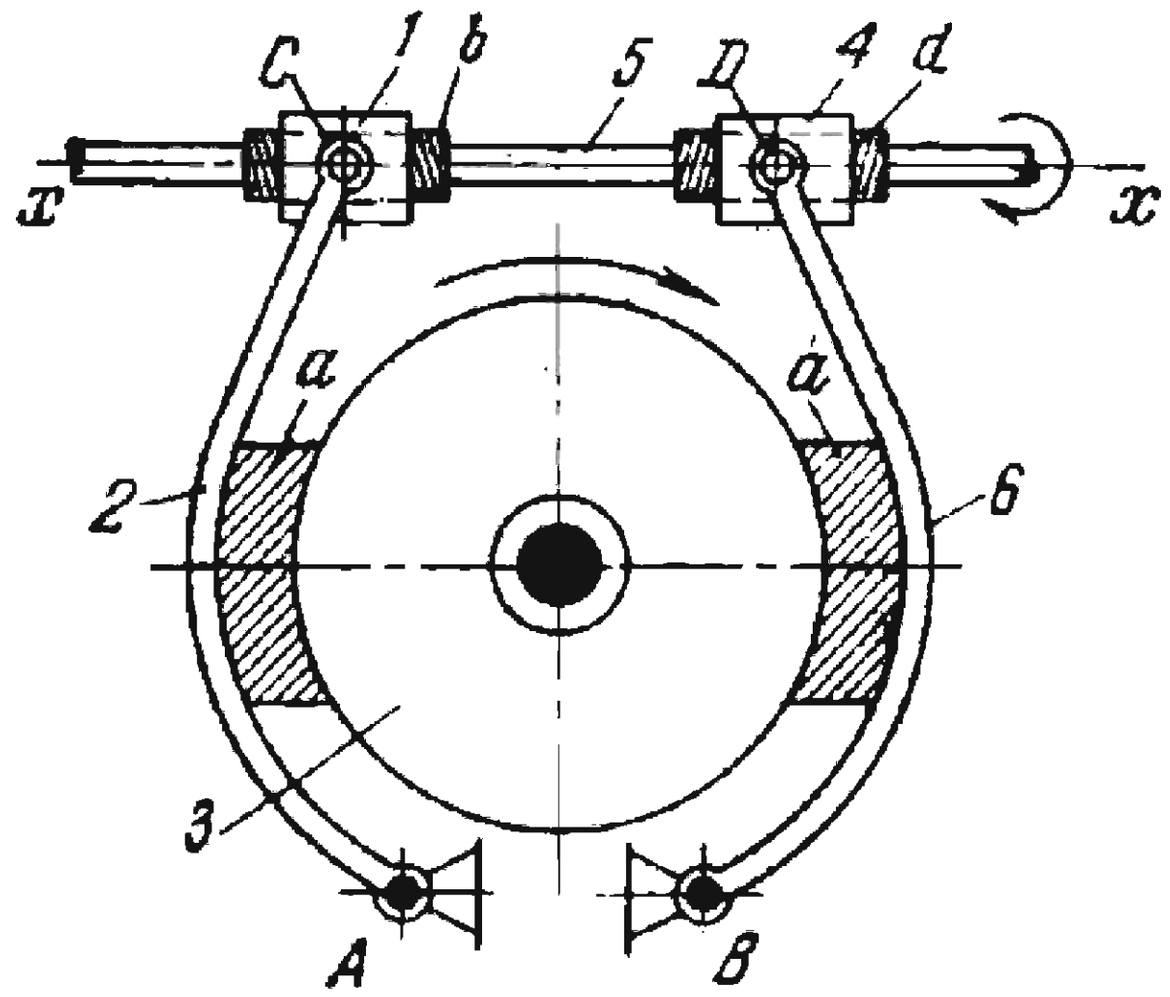
$$z = \frac{1}{k} xy$$

where k is a constant dimension of the mechanism. The magnitude of z is proportional to the angle φ of rotation of gear *6*. We have

$$\varphi = \frac{1}{rk} xy$$

where r is the pitch radius of gear *6*.

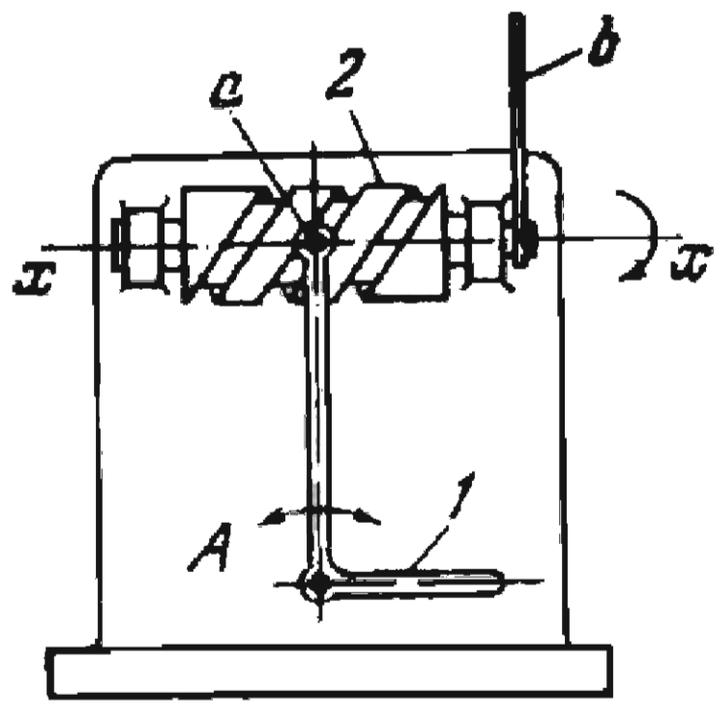
2267	LEVER-SCREW SHOE BRAKE	LS Br



Levers *2* and *6* turn about fixed axes *A* and *B* and have shoes *a* which embrace brake drum *3*. Link *5* has screws *b* and *d* with right- and left-hand threads and is connected by screw pairs *C* and *D* to links *1* and *4*. Links *2* and *6* are connected by turning pairs *C* and *D* to links *1* and *4*. Shoes *a* are pressed against drum *3* to apply the brake by turning link *5* about axis *x-x*.

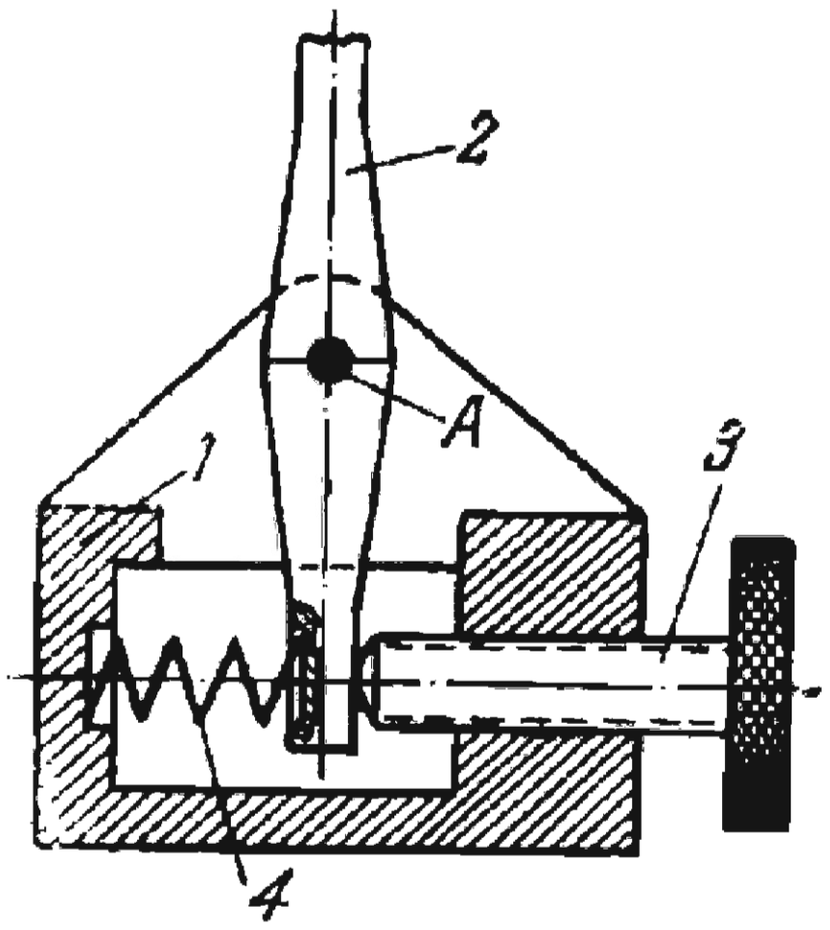
13. MECHANISMS OF MEASURING AND TESTING DEVICES (2268 through 2271)

2268	LEVER-SCREW INDICATOR MECHANISM	LS M



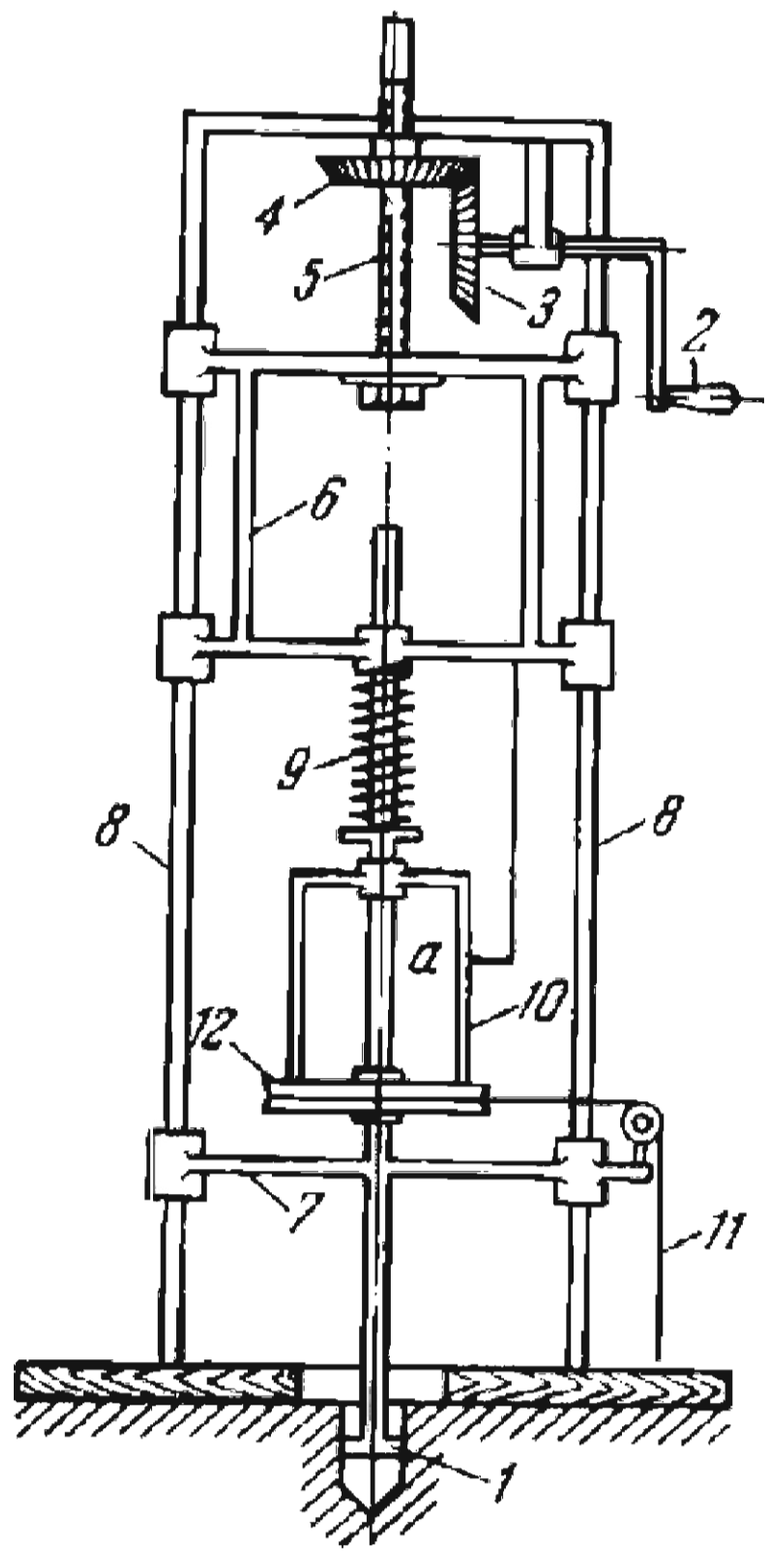
Link *2* rotates about fixed axis *x-x* and has a screw thread with a large helix angle. Link *1* turns about fixed axis *A* and has pin *a* which enters the thread groove. When lever *1* is turned, pin *a* causes link *2* to turn together with indicator hand *b*.

2269	LEVER-SCREW HAND SETTING MECHANISM	LS M



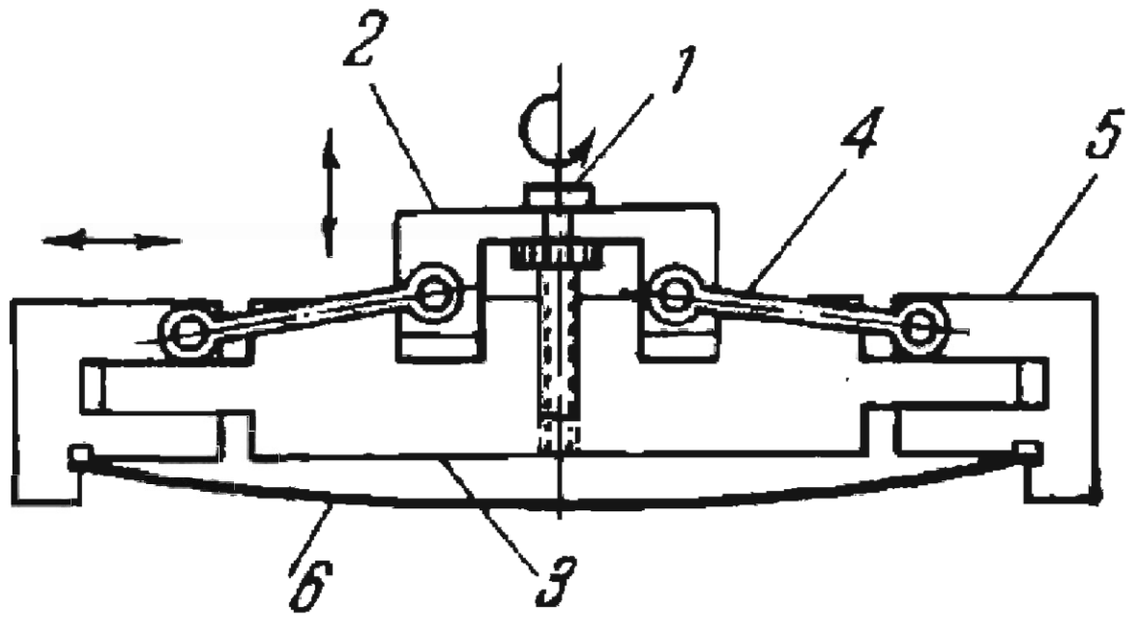
Link *2* turns about fixed axis *A* and is rigidly attached to the hand of an indicating instrument. Link *3* is connected by a screw pair to fixed link *1* and its tip contacts the shank of link *2*. Spring *4* keeps the links in contact with each other. Link *2* is set in the required position by turning link *3*.

2270	SCREW-TYPE ELASTIC-LINK MECHANISM OF THE GORYACHKIN DENSIMETER	LS M



The vertical displacement of plunger *1*, sunk into the soil to determine its density, is transmitted from handle *2* through bevel gears *3* and *4*. Gear *4* is a nut which traverses screw *5* vertically and, with it, the whole system consisting of frames *6* and *7* which slide along fixed frame *8* as on guides. Measuring spring *9* is arranged between frames *6* and *7*. The compression of the spring due to the force of resistance of the soil to wedge action brings frames *6* and *7* closer together. This is recorded by pencil *a* on a paper strip attached to revolving drum *10*. The drum is rotated by a spring (not shown) as cable *11* winds on pulley *12*.

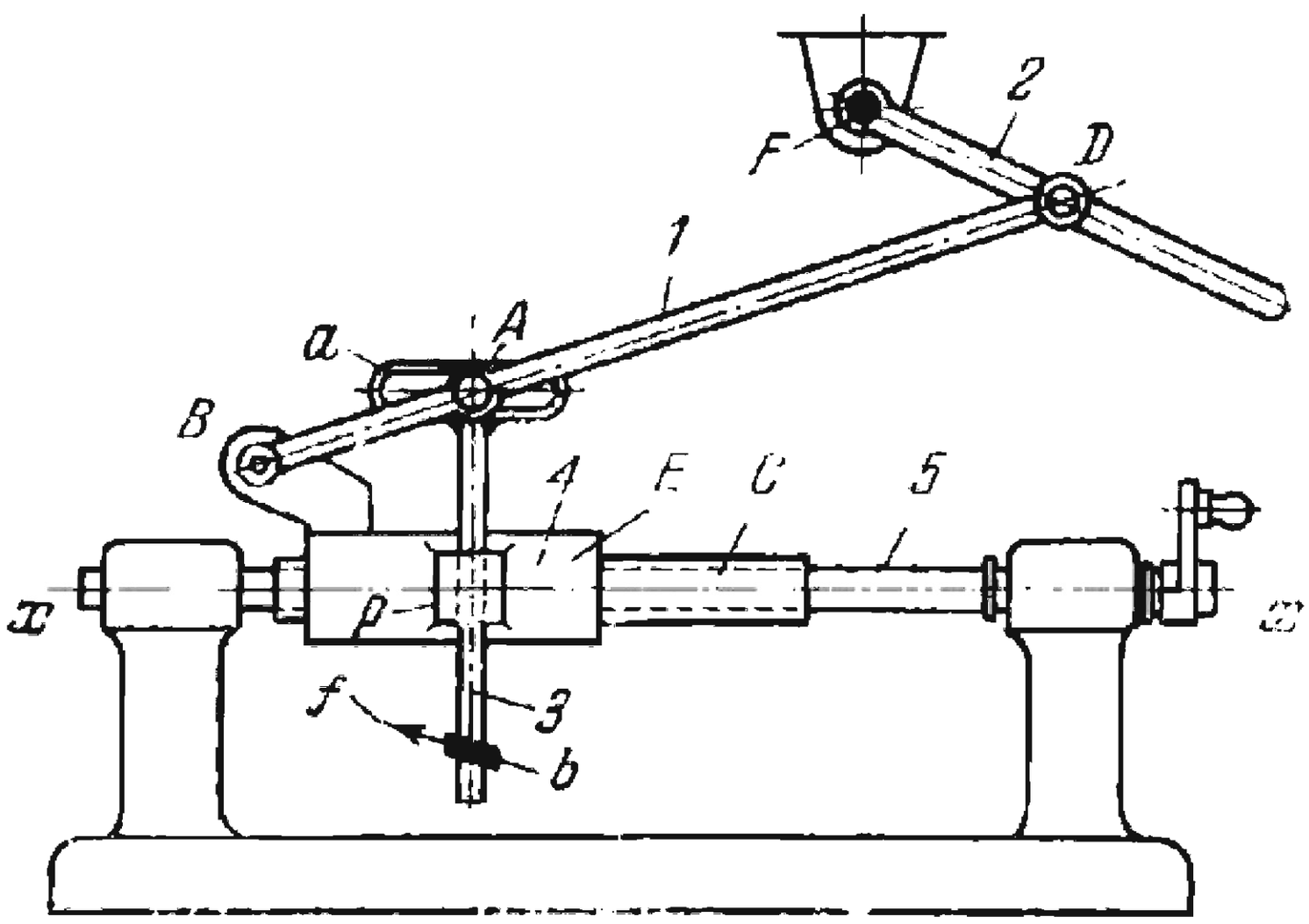
2271	CHEBYSHEV LEVER-SCREW CURVATURE MEASURING DEVICE	LS M



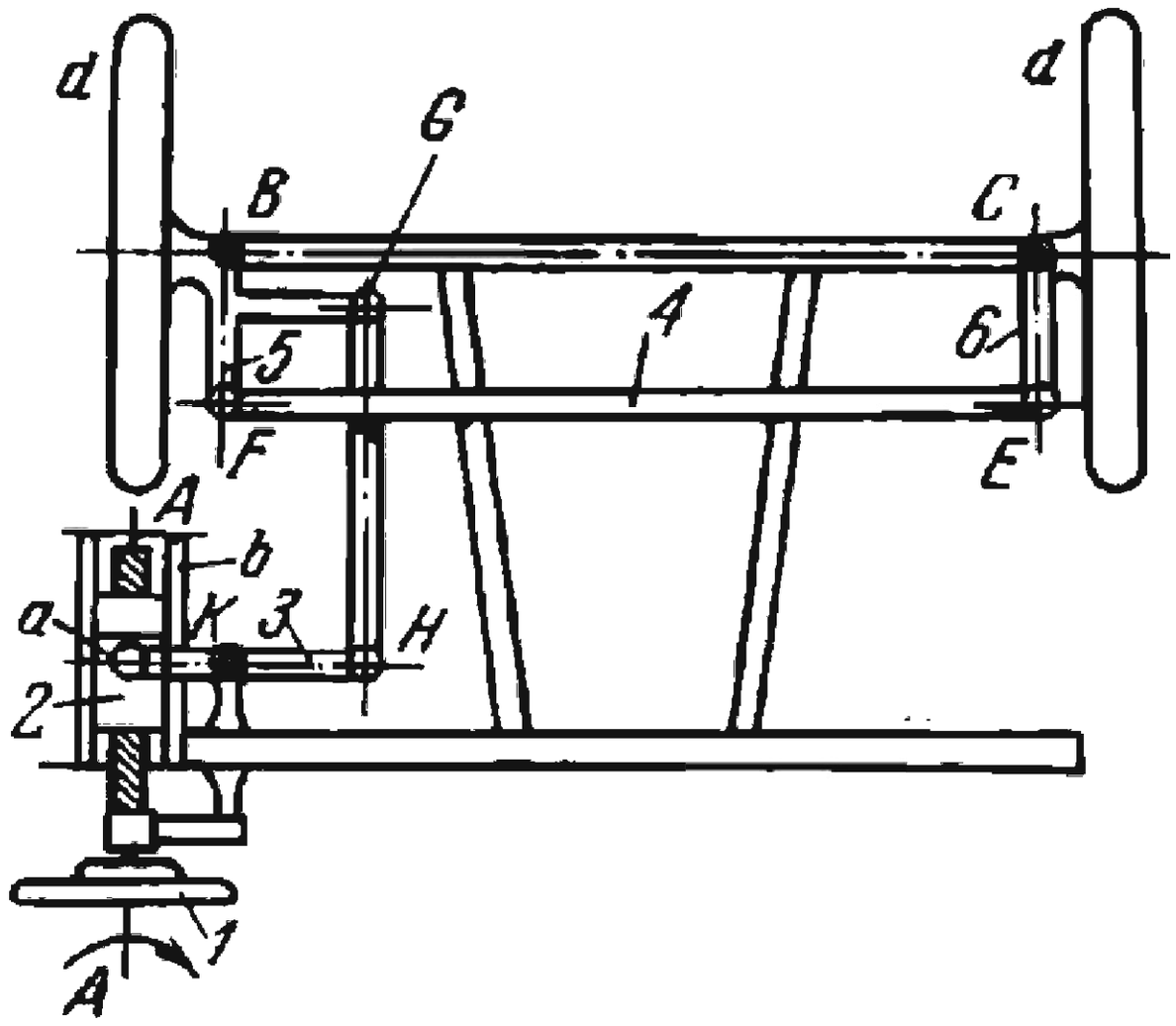
When screw *1* is turned, slider *2* is displaced in the guides of body *3* and sliders *5* are brought either closer together or farther apart, leading to greater or lesser deflection of elastic strip *6*. At small deflections, the elastic line of the strip differs only slightly from a circular arc whose radius is determined from the displacement of slider *2*.

14. MECHANISMS OF OTHER FUNCTIONAL DEVICES
(2272 through 2288)

2272	LEVER-SCREW MECHANISM OF A SLIDE	LS FD

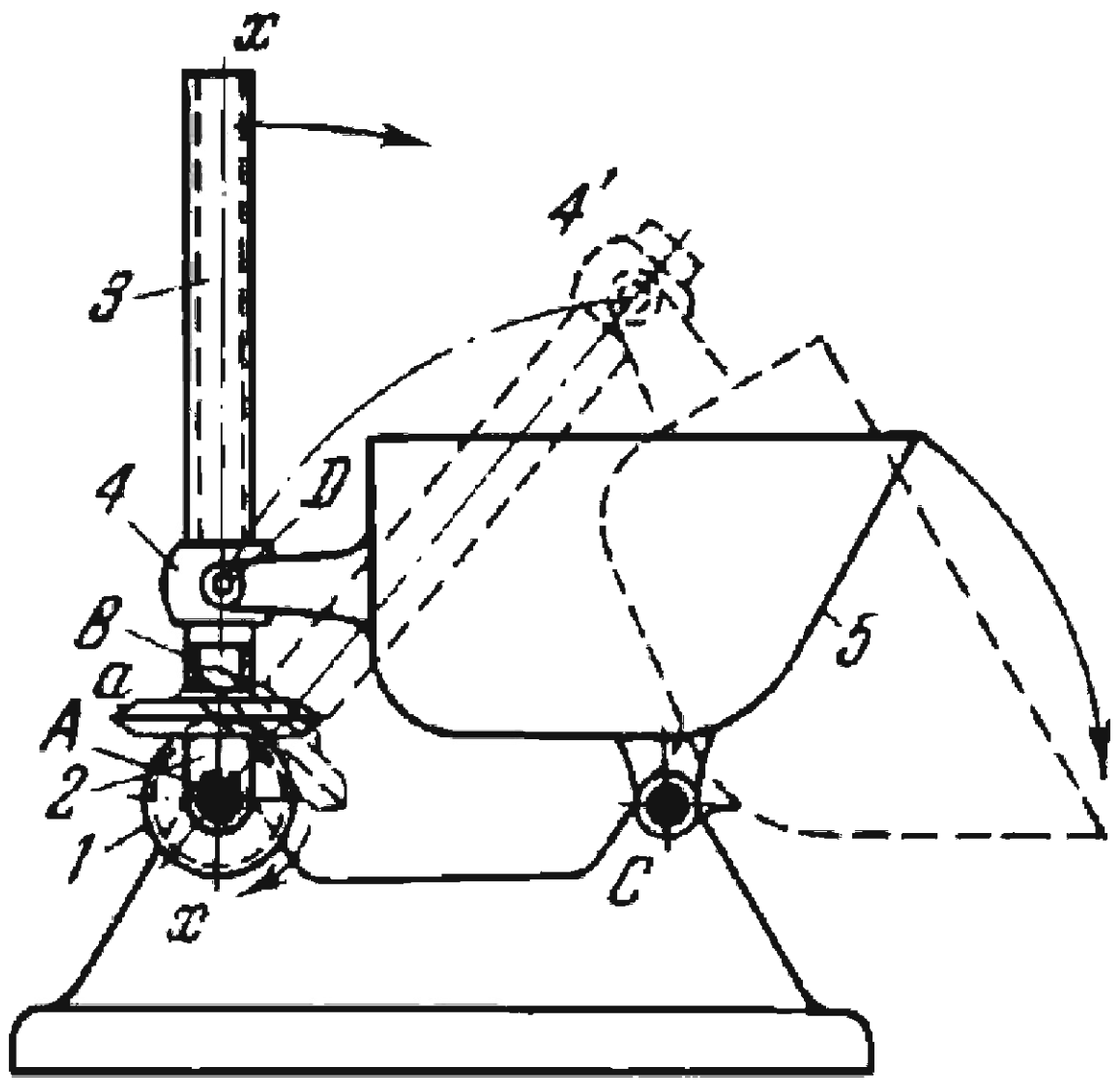


Link *5* rotates about fixed axis *x-x* and is connected by screw pair *E* to link *4*. Link *1* is connected by turning pairs *B* and *D* to links *4* and *2*. Link *2* turns about fixed axis *F*. Link *3* slides in guide *p* of link *4* and has slot *a* along which pin *A* of link *1* slides. When link *5* is rotated, link *4* is traversed along axis *x-x*. The motion of link *4* is transmitted to links *1* and *2* and to link *3* carrying tool *b*. The shape of the curve described by nose *f* of tool *b* is varied by adjusting pivot *D* of link *1* along the axis of link *2*.



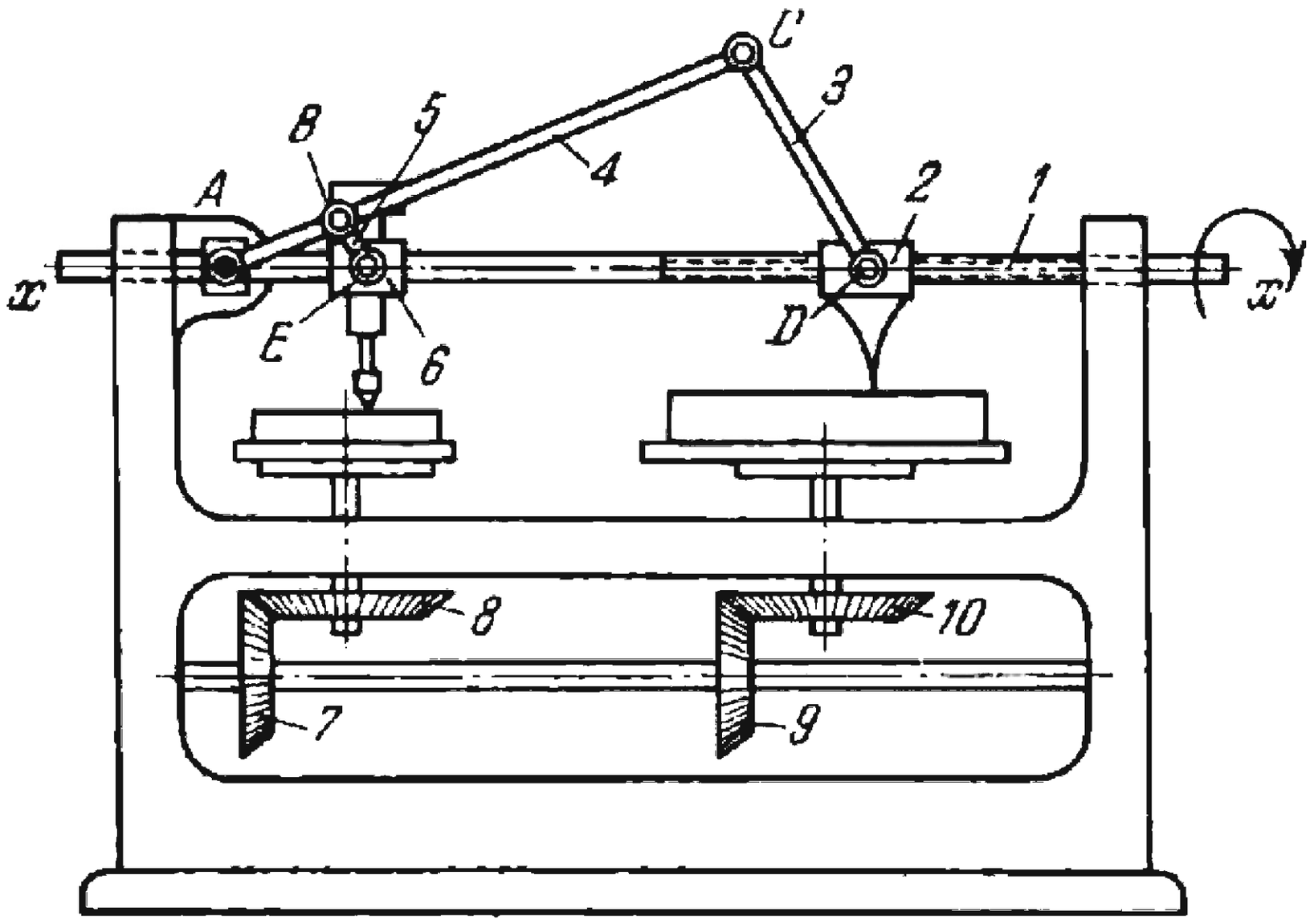
The lengths of the links comply with the conditions: $\overline{FE} = \overline{BC}$ and $\overline{BF} = \overline{CE}$. Link *1* rotates about axis *A* of the wagon frame and is connected by a screw pair to slider *2* which moves along guide *b*. Link *3* of four-bar linkage *KHGB* turns about axis *K* of the wagon frame. Link *4* of parallel-crank linkage *BFEC* is connected by turning pairs *F* and *E* to links *5* and *6* to which the axle ends of wheels *d* are rigidly attached. Wheels *d* with their axle ends are turned about axes *B* and *C* of the wagon frame by rotating screw *1* about axis *A*.

2274	LEVER-SCREW VAT TIPPING MECHANISM	LS FD



Bevel gear *1* rotates about fixed axis *A* and meshes with bevel gear *a* which is rigidly attached to link *3*. Link *3* is connected by turning pair *B* to link *2* which turns about axis *A*. Link *3* is connected by a screw pair to link *4* which, in turn, is connected by turning pair *D* to vat *5*. Vat *5* turns about fixed axis *C*. When bevel gear *1* is rotated about axis *A*, link *4* is traversed along axis *x-x* to position *4'*, tipping the vat about axis *C*.

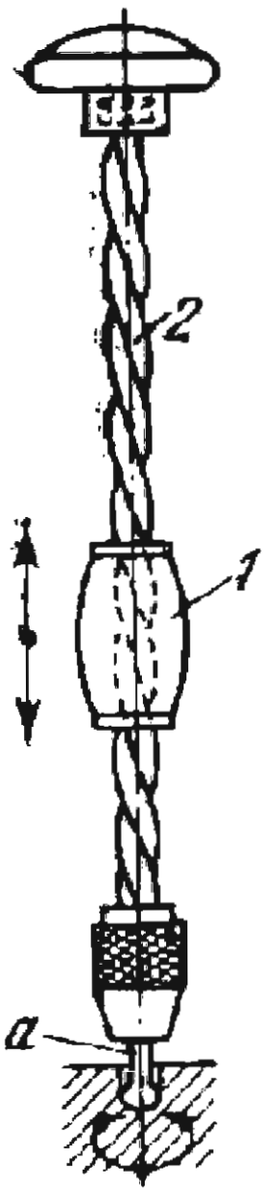
2275	LEVER-SCREW MECHANISM OF A COPYING MACHINE	LS FD



The lengths of the links comply with the condition: $\overline{CD} : \overline{BE} = \overline{AC} : \overline{AB} = k$. Link *1* rotates about fixed axis *x-x* and is connected by a screw pair to link *2* and by sliding pair *E* to slider *6*. Link *4* turns about fixed axis *A* and is connected by turning pairs *B* and *C* to links *5* and *3* which, in turn, are connected by turning pairs *E* and *D* to slider *6* and link *2*. When link *1* is rotated, links *2* and *6* have similar translational motion with the similarity factor *k*, thereby accomplishing the copying process. Bevel gears *7*, *8*, *9* and *10* rotate the workpiece and the template being copied.

2276 SCREW-TYPE HAND DRILL

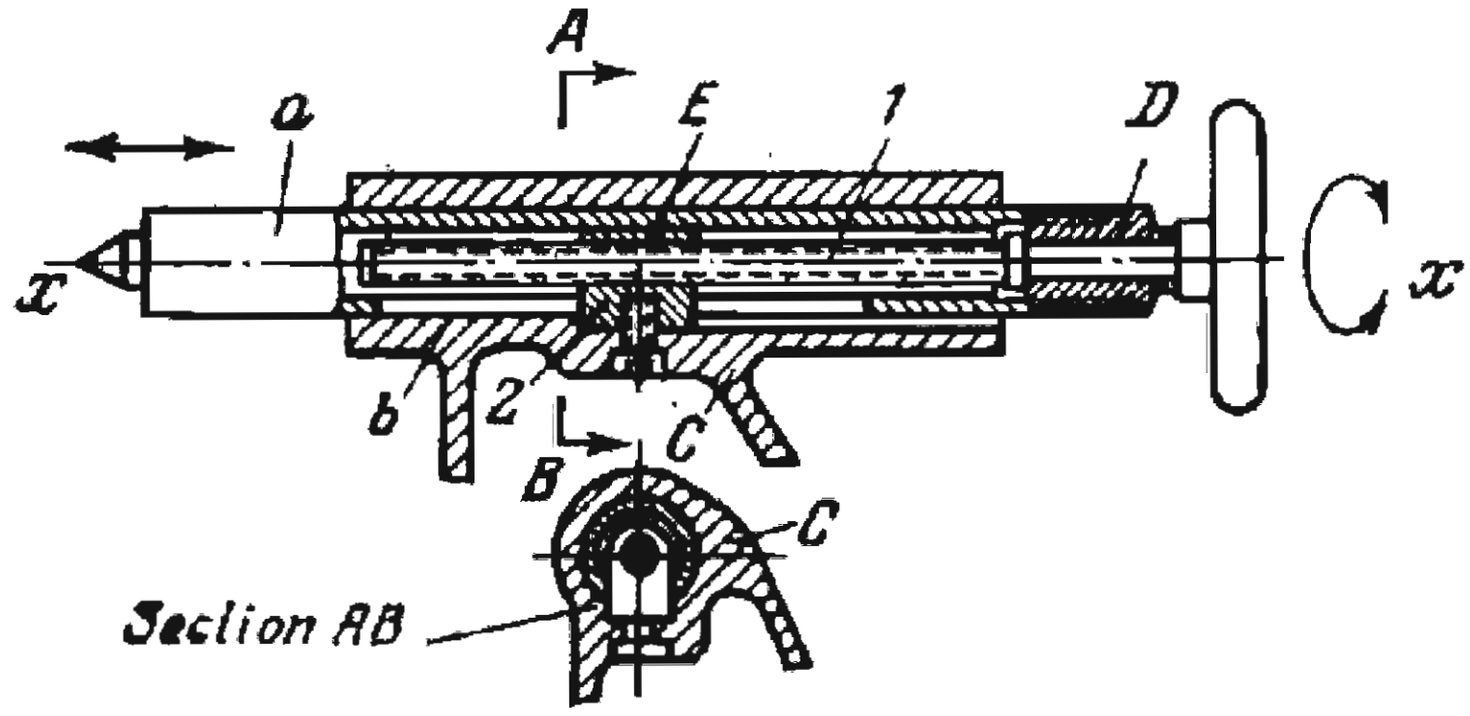
LS
FD



Link *2* has a screw thread with a large helix angle. Link *1* is connected by a screw pair to link *2* which rotates about a vertical axis. Sliding motion of link *1* is converted into rotation of drill *a* of link *2*.

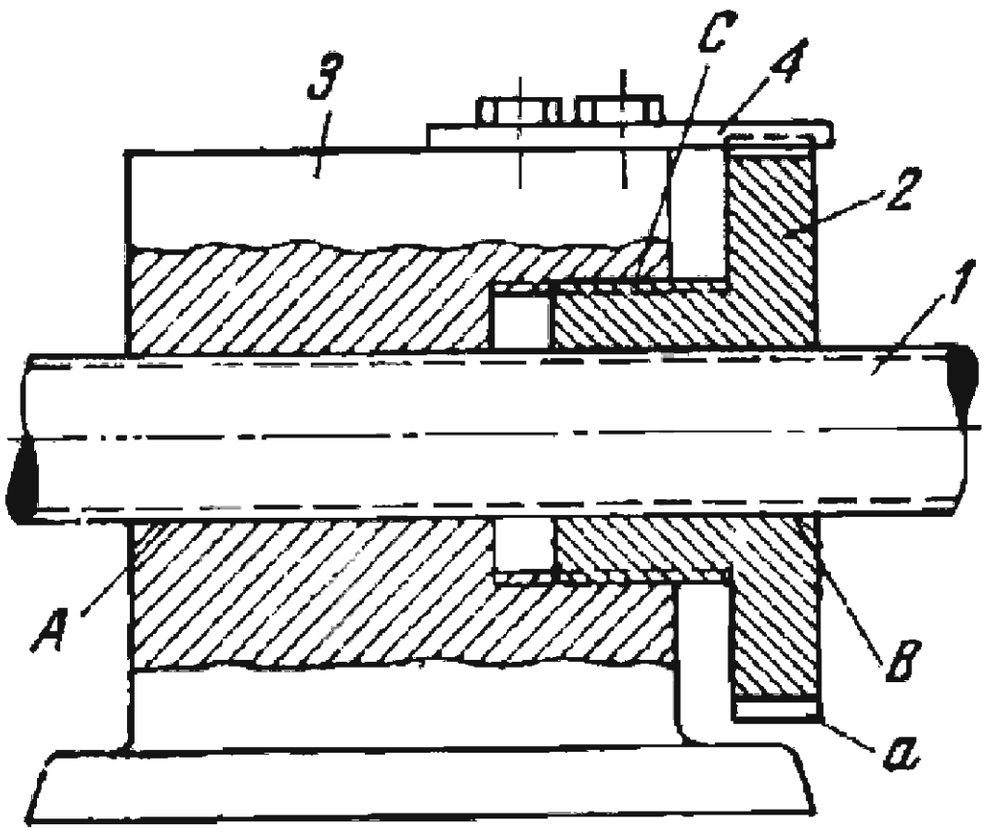
2277 SCREW-TYPE MECHANISM OF A LATHE TAILSTOCK

LS
FD



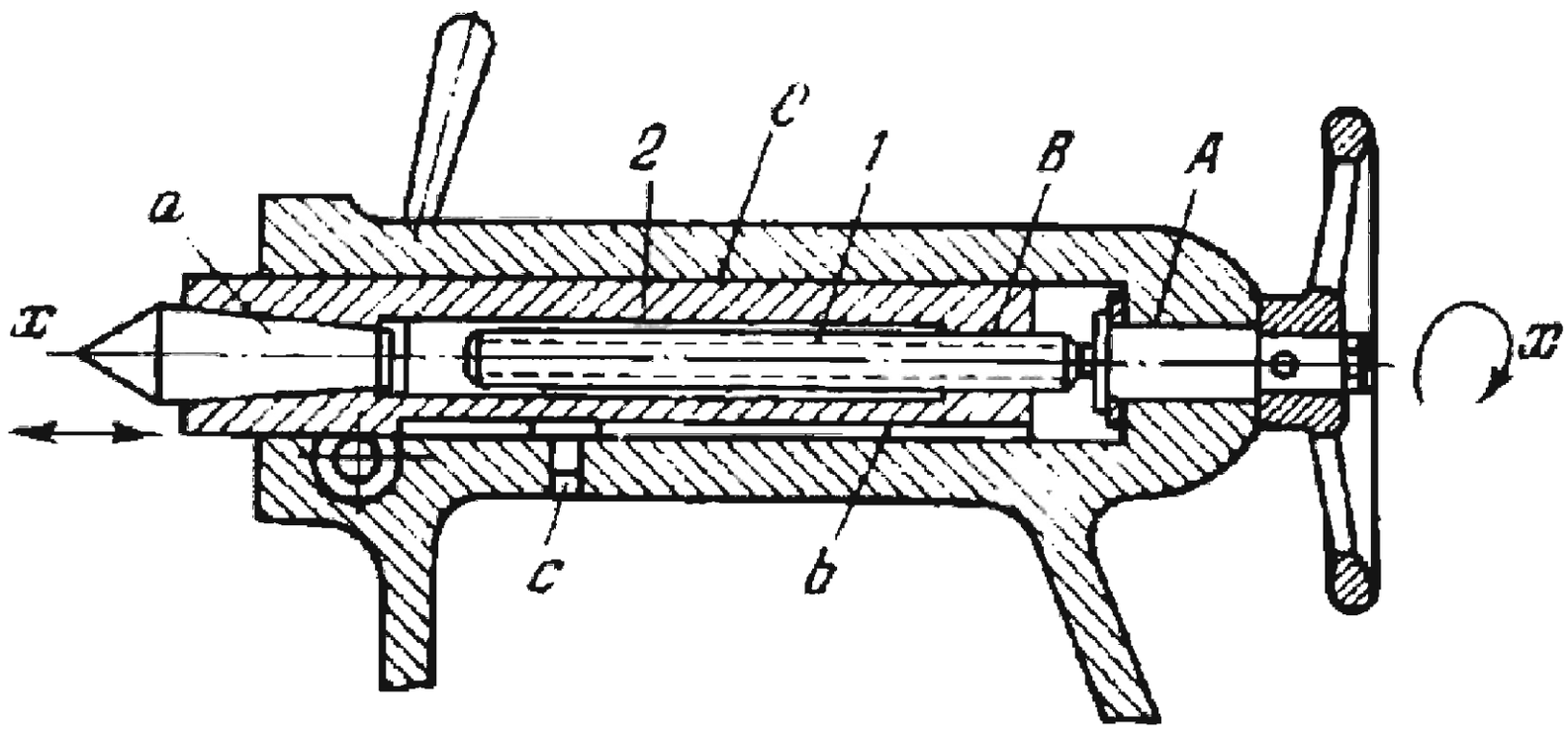
Link *1* is connected by turning pair *D* to tailstock spindle *a* and by screw pair *E* to link *2* which is fixed in housing *C*. Slot *b* of tailstock spindle *a* slides along link *2*. Spindle *a* is connected by a sliding pair to fixed housing *C*. When screw *1* is rotated, tailstock spindle *a* is advanced or retracted along axis *x-x*.

2278	SCREW-TYPE BACKLASH ELIMINATOR	LS FD



Link *1* is connected by screw pairs *A* and *B* to nuts *3* and *2*. Nut *2* is connected by screw pair *C* to nut *3*. Nut *2* has teeth *a* cut on its flange. By means of this supplementary nut *2*, screwed into main nut *3*, backlash is eliminated in screw pair *A*. Supplementary nut *2* is locked in the required position by strip *4* which enters the corresponding tooth space *a*.

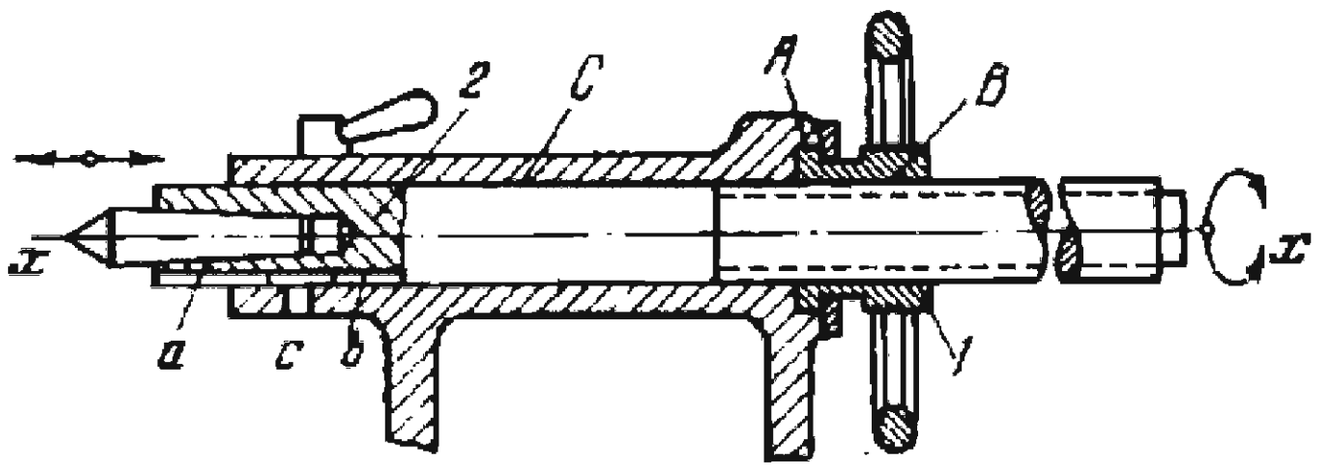
2279	SCREW-TYPE MECHANISM OF A LATHE TAILSTOCK	LS FD



Link *1* (screw) is connected by turning pair *A* to the fixed link (housing) and by screw pair *B* to link *2* (tailstock spindle). Link *2* is connected by sliding pair *C* to the fixed link. Slot *b* of link *2* slides along fixed key *c*. When screw *1* is rotated, centre *a* and tailstock spindle *2* are advanced or retracted along axis *x*-*x*.

2280 SCREW-TYPE MECHANISM OF A LATHE TAILSTOCK

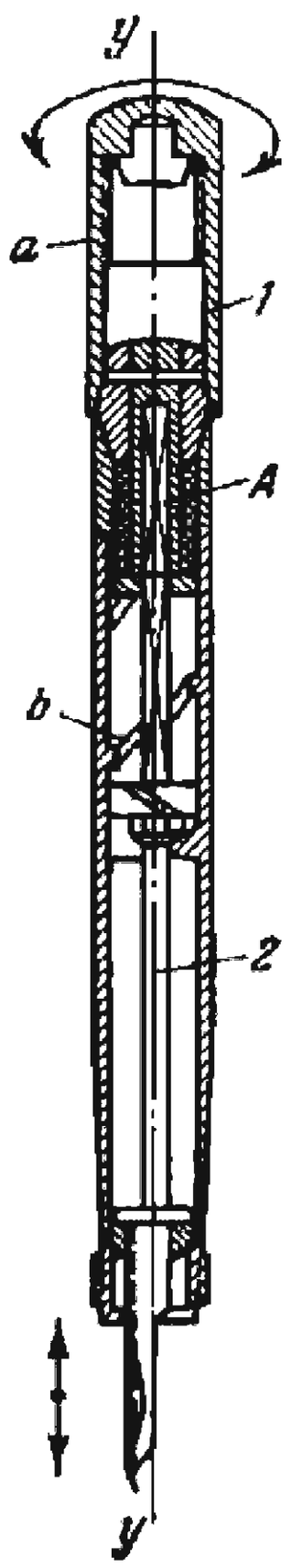
LS
FD



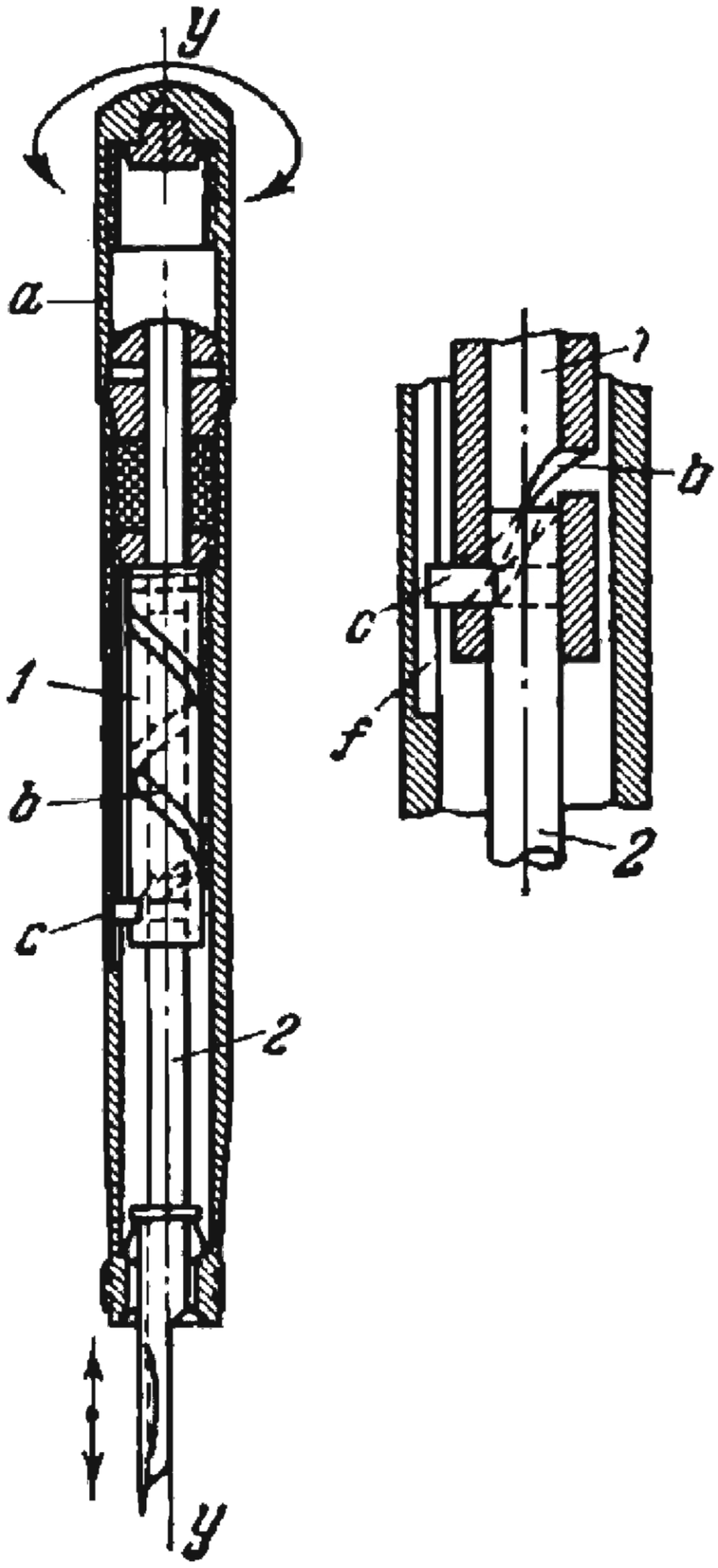
Link *1* (handwheel) is connected by turning pair *A* to the fixed link (housing) and by screw pair *B* to link *2* (tailstock spindle). Link *2* is connected by sliding pair *C* to the fixed link. Slot *b* of link *2* slides along fixed key *c*. When handwheel *1* is rotated, centre *a* and tailstock spindle *2* is advanced or retracted along axis *x*-*x*.

2281 SCREW-TYPE MECHANISM OF A FOUNTAIN PEN

LS
FD

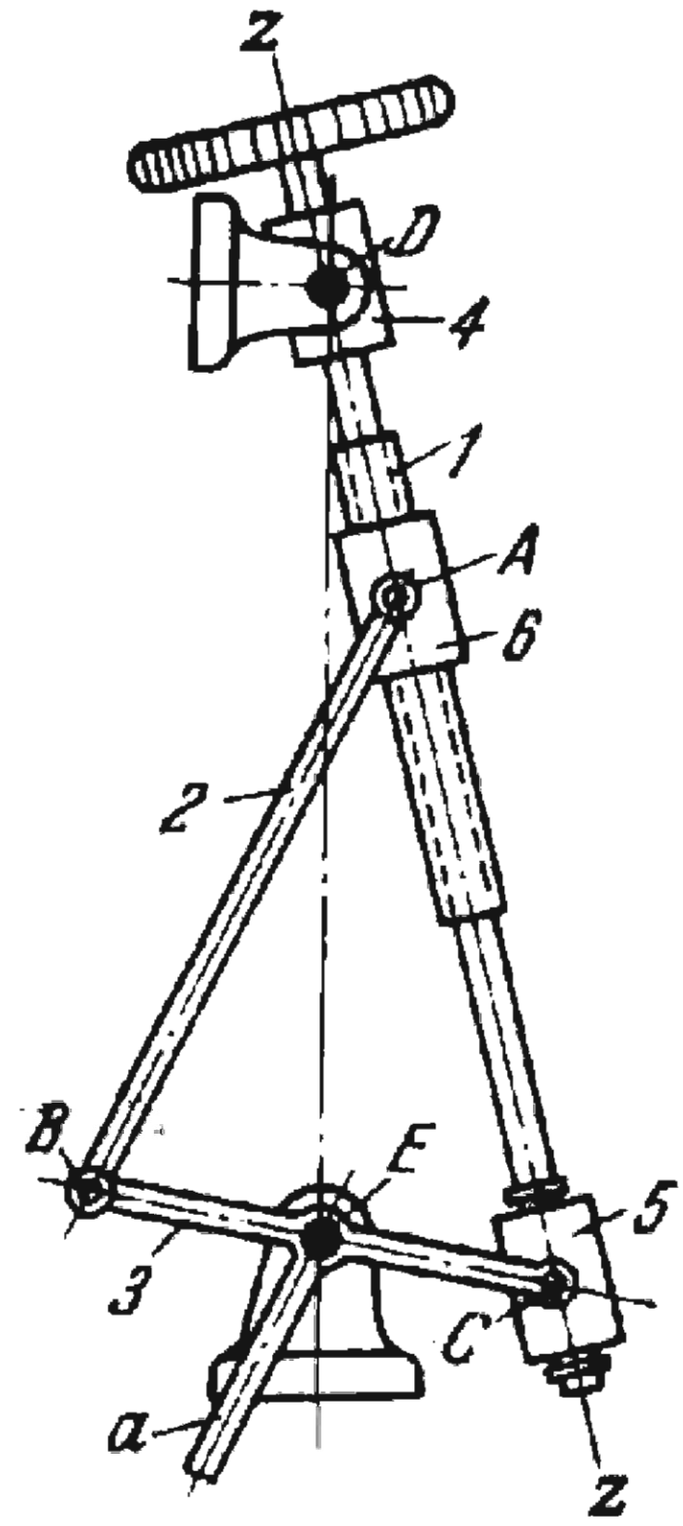


Head *a* of link *1* rotates about axis *y*-*y*. Link *1* is connected by sliding pair *A* to link *2* which, in turn, is connected by a screw pair to the body of the pen. A helical thread groove *b* of large pitch is cut inside the body. When link *1* is rotated, link *2* has a screw motion.



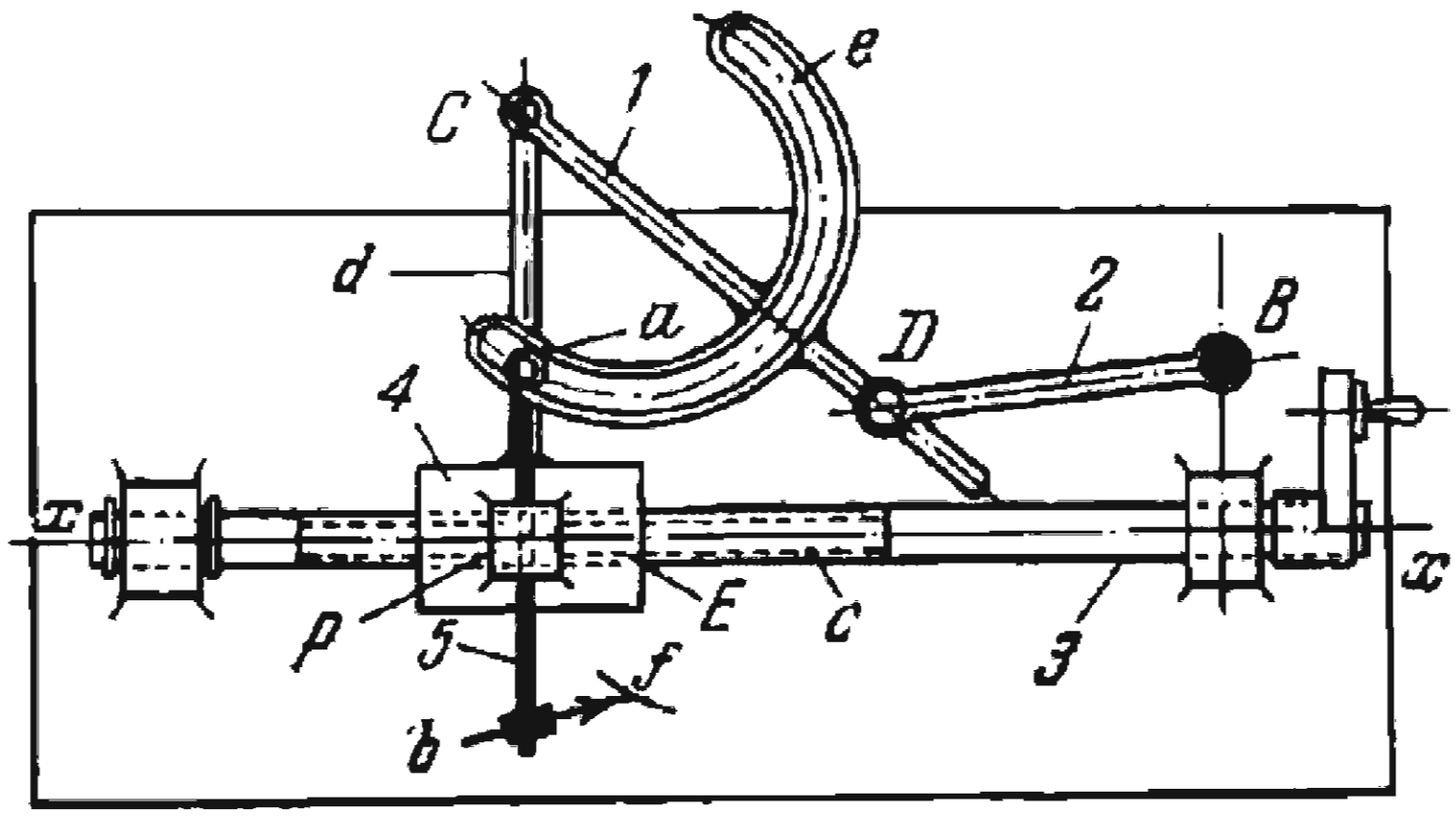
Head *a* of link *1* rotates about axis *y*-*y*. Link *1* has helical thread groove *b* of large helix angle. Pin *c* of link *2* slides in helical groove *b* and in guide slot *f* of the pen body. Rotation of link *1* is converted into sliding motion of link *2*.

2283	LEVER-SCREW MECHANISM OF A STEERING SYSTEM	LS FD



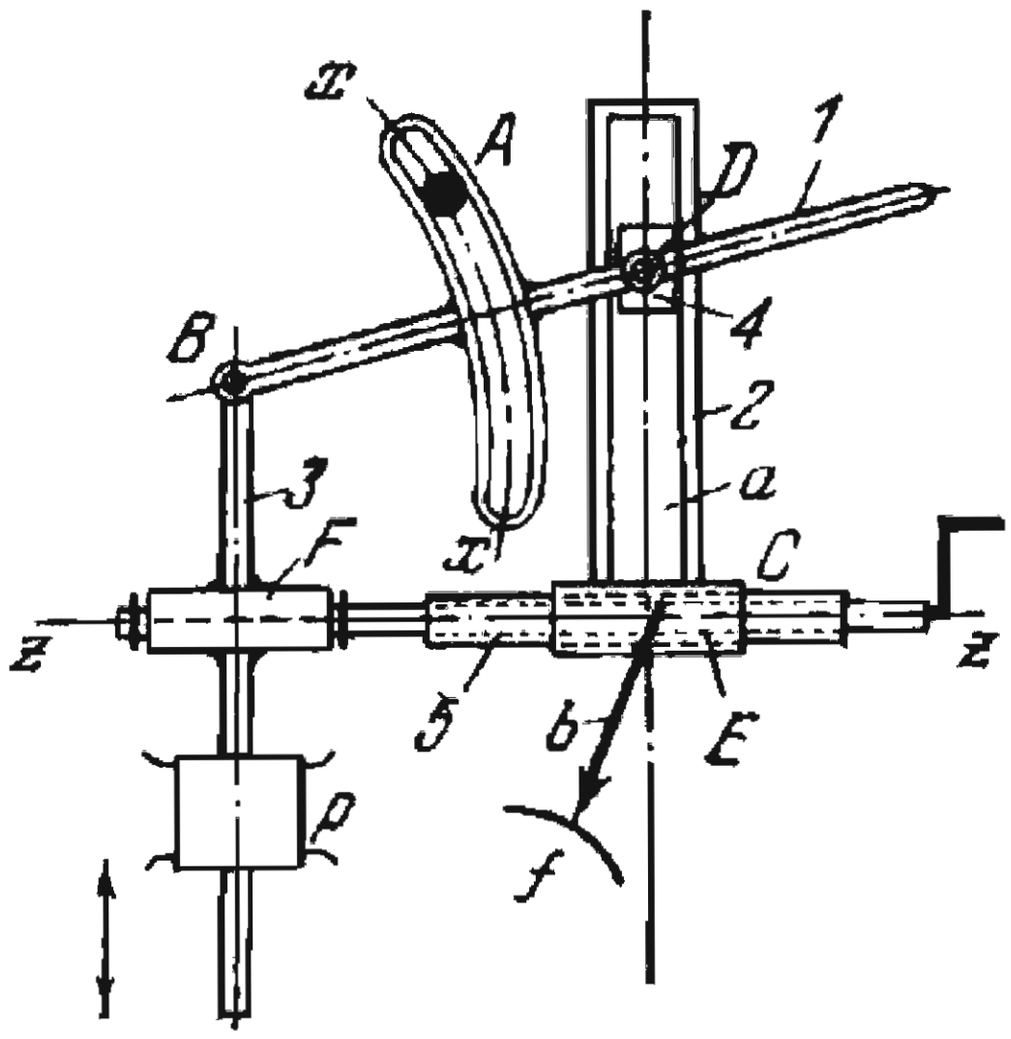
Link *4* turns about fixed axis *D*. Link *1* is connected by a turning and sliding pair to link *4*, by a turning pair to link *5* and by a screw pair to link *6*. Link *2* is connected by turning pairs *A* and *B* to links *6* and *3*. Link *3* turns about fixed axis *E* and is connected by turning pair *C* to link *5*. When link *1* is rotated, link *6* is traversed along axis *z-z* and transmits motion through link *2* to link *3* which is rigidly attached to rudder *a*. Rod *1* of the screw rotates freely in bearing *5* and rotates and slides in bearing *4*.

2284	LEVER-SCREW MECHANISM OF A SLIDE	LS FD



Link *3* rotates about fixed axis *x-x* and is connected by screw pair *E* to link *4* which has extension *d*. Link *4* is connected by turning pair *C* to link *1* which, in turn, is connected by turning pair *D* to link *2*. Link *2* turns about fixed axis *B*. Rigidly attached to link *1* is a circular slotted member in whose slot *e* pin *a* of link *5* slides. Link *5* slides in guide *p* of link *4*. Tool *b* can be set up in various positions on link *5*. When link *3* is rotated, link *4* with its rigidly attached extension *d* is traversed along axis *x-x*. Link *5* with tool *b* slides in a direction perpendicular to axis *x-x*. The shape of the curve described by nose *f* of tool *b* is varied by adjusting pivot *D* of link *2* along the axis of link *1*.

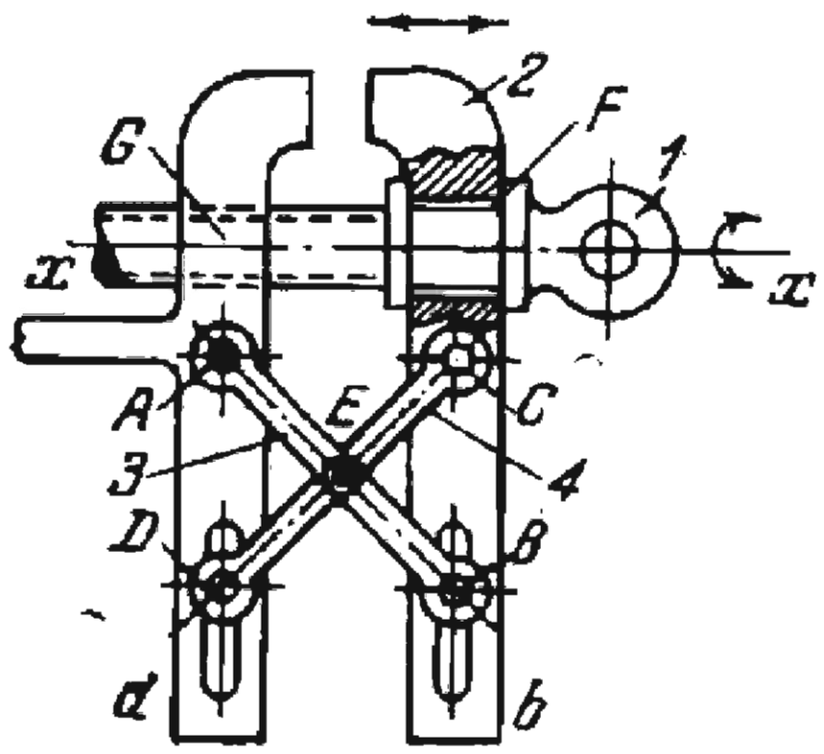
2285	LEVER-SCREW MECHANISM OF A SLIDE	LS FD



Link *5* rotates about axis *z-z* and is connected by screw pair *E* to link *2* to which a slotted member with slot *a* is rigidly attached. Slider *4* moves along slot *a* and is connected by turning pair *D* to link *1* which, in turn, is connected by turning pair *B* to link *3*. Link *3* slides in fixed guide *p* and is connected by turning pair *F* to link *5*. Rigidly attached to link *1* is a circular slotted member *x-x* which slides along fixed pin *A*. Tool *b* can be set up in various positions on link *2*. When link *5* is rotated, link *2* is traversed with its slotted member along which slider *4* moves. The motion of slider *4* is transmitted to link *1* which, in turn, transmits motion to link *3*, moving only vertically up or down in guide *p*. Together with link *3*, link *5* also has translational motion. Thus nose *f* of cutting tool *b* has complex motion along a curve whose curvature depends upon the position where pin *A* is fixed on the base.

2286 LEVER-SCREW SLOTTED-LINK MECHANISM OF A PARALLEL VISE

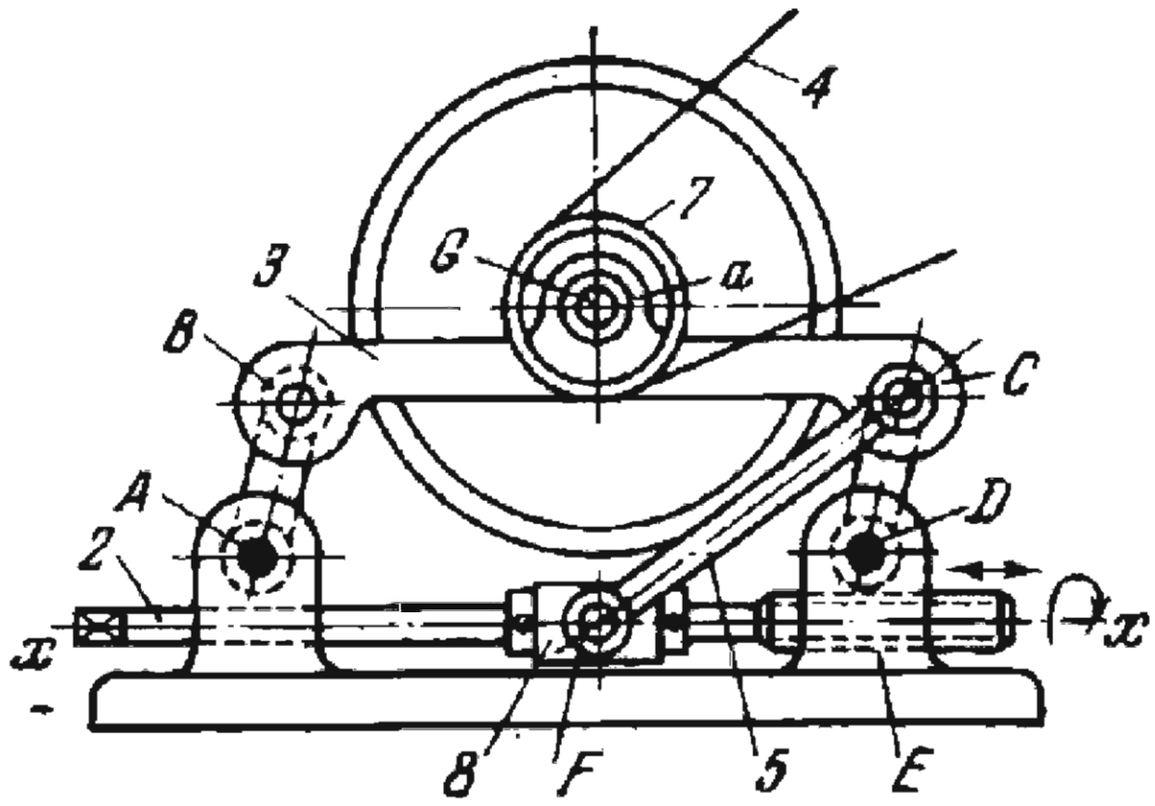
LS FD



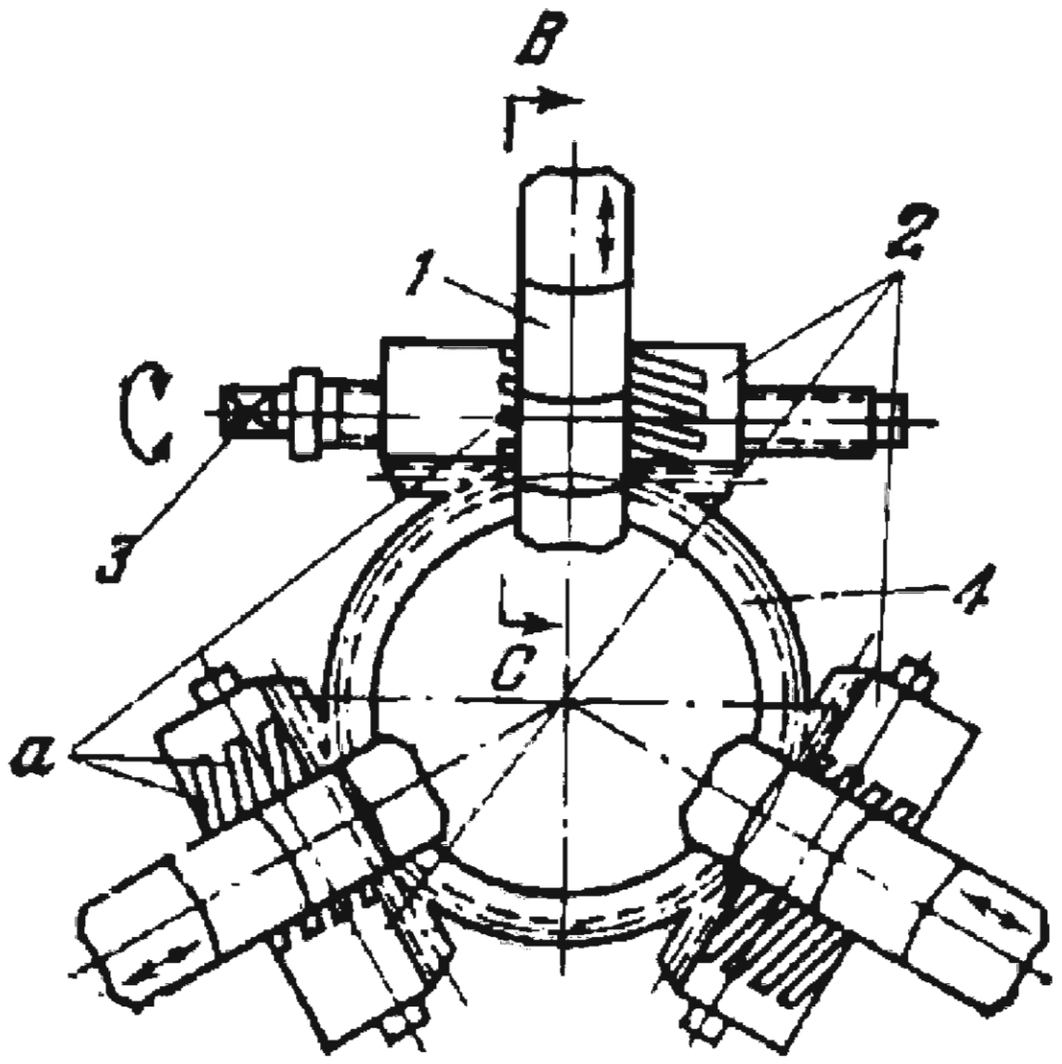
The lengths of the links comply with the condition: $\overline{AE} = \overline{EB} = \overline{DE} = \overline{EC}$. Link *1* (vise screw) rotates about fixed axis *x-x* and is connected by turning pair *F* to link *2* (movable jaw) and by screw pair *G* to the fixed link (fixed jaw). Link *3* turns about fixed axis *A* and has pin *B* sliding along slot *b* of link *2*. Link *4* is connected by turning pair *C* to link *2* and has pin *D* sliding along fixed slot *d*. Links *3* and *4* are connected together by turning pair *E*. When screw *1* is rotated, movable jaw *2* advances with translational motion to clamp the workpiece.

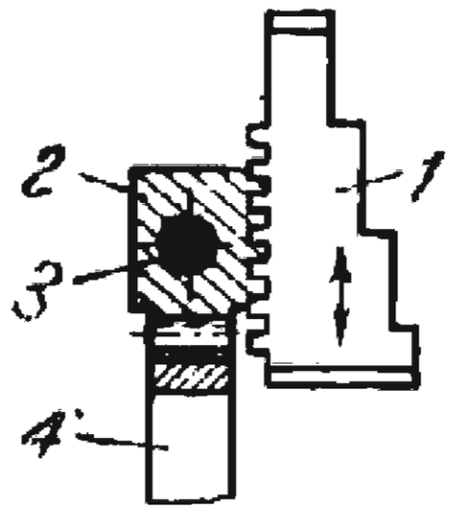
2287 LEVER-SCREW MECHANISM FOR BELT TENSION ADJUSTMENT

LS FD



The lengths of the links comply with the conditions: $\overline{AB} = \overline{DC}$ and $\overline{BC} = \overline{AD}$, i.e. figure *ABCD* is a parallelogram. Link *2* rotates about fixed axis *x-x* and is connected by screw pair *E* to the fixed link and by a turning pair to link *8*. Link *5* is connected by turning pair *F* to link *8* and by turning pair *C* to link *3* which mounts bearing *a*. Pulley *7* rotates about axis *G*. The tension of belt *4* is adjusted by translational displacement of link *3* for which purpose point *F* is adjusted along axis *x-x*. This is done by rotating link *2* about axis *x-x*.





When screw *3* is rotated, it imparts sliding motion to the rack *2* to which it is connected by a screw pair. This rotates ring gear *4* which meshes with three racks *2* so that the other two racks *2* are also moved the same amount. Racks *2* also have inclined rack teeth *a* that mesh with corresponding teeth on the base of chuck jaws *1*. Thus, when screw *3* is rotated, jaws *1* are either advanced toward the centre to clamp the workpiece or they are retracted to release the workpiece.

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To the Reader

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